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The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Effect of Cleaning Water Mains in Kansas City

Volume of Flow Restored to Capacity of New Pipe — Saving in Coal Consumption Almost Paid for Cost of Cleaning — Does Not Damage Pipe — Method of Testing Mains Described — Cost of Operation

BY CHARLES S. FOREMAN

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WATER works engineers and superintendents usually know the necessity of cleaning certain water or feeder mains in the system which they may be operating but before they are able to obtain authorization and appropriations to cover such work, they are called upon to answer many questions which may be put to them by a Board of Commissioners.

The author believes that the publication of his experience in water main cleaning in Kansas City during the past three years will be of value to other water works superintendents desirous of instituting similar work in the system under their jurisdiction, and that knowledge of the following essential facts, based upon his experiences, will help them to answer some of the questions which are usually asked.

1. That the cleaning can be so arranged that a main need not be out of service longer than 12 hours.
2. That the cleaning process is not injurious to the main.
3. That an increase in carrying capacity of from 60 per cent to 85 per cent was obtained in large mains and that the carrying capacity of such mains was restored to that of new pipe.
4. That the saving in coal costs alone, derived from cleaning will pay the entire costs of cleaning within from one to three years.
5. That the laying of additional mains to obtain increased capacity can be postponed until the consumption demands are equal to the maximum capacity of the old main on the basis of new pipe.
6. That when taking as credits, such items as coal

lines, 2 in. pipe was connected to each of these taps and Baltimore, a distance of approximately 6,000 ft., for determining the interior condition and carrying capacity of this pipe; the pipe having been laid in 1886. The tests were made by making taps exactly 1,000 ft. apart upon a straight length of the main, there being no services or connections to the main between gauging points. At each of these points 1 inch corporation cocks were installed for inserting pitometers and additional corporation cocks for pressure 1,000 ft. of this pipe laid along the surface of the ground bringing the two together so that a U tube could be connected in to measure the differential pressure between the two points. The 30 in. pipe was double traversed at each pit and the average traverse coefficient obtained. A pitometer was then set at each pit for checking quantities flowing through the 30 in. main.

The scale on the differential U tube was graduated in 1/100 ft. divisions and by using a liquid of specific gravity of 2.00 in this tube, the readings obtained were in feet loss of head per thousand feet. The advantages inherent in this method are that it is not necessary to obtain the difference in elevation between the two points, and that it eliminates the use of spring gauges. Piezometers could not be used because of the high pressure, all of the lines being under pressure of 125 to 150 pounds per square inch. The pipe and connections for bringing the two pressures to the differential U tube should be water tight for accurate results. However, we found no difficulty in making them up tight. We also found that with pipe of 1½ to 2 in. diameter a slight leak did not materially affect the results. The test extended over a 24 hour period so that both maximum

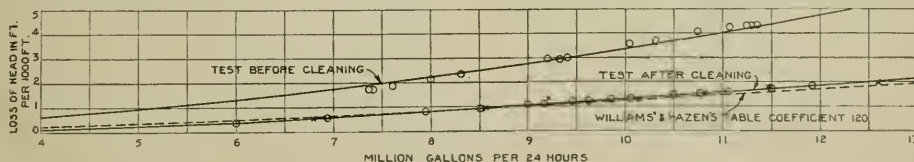


CHART NO. 1—RESULTS OBTAINED AFTER CLEANING 30-IN. MAIN

saving and postponement of obligatory laying of new mains, the entire cost of cleaning is saved within from six months to one year.

In Kansas City, Mo., for two or three years prior to the summer of 1918 there was always a lack of adequate pressure in the north and east portions of the city. This district is fed from the Turkey Creek pumping station through one 20 in. and one 30 in. cast iron water main. The question of laying additional feeder mains into these districts was abandoned because of the exceedingly high prices of material and the lack of funds. Therefore the proposition of increasing the carrying capacities of the old mains by the cleaning process was resorted to in the fall of 1918.

Tests of High Pressure Mains

Tests were run on the 30 in. high pressure discharge line extending from Turkey Creek station to 17th and

and minimum velocities in the pipe could be obtained. The result of this test is shown graphically on Chart No. 1.

It will be noted that the average pipe coefficient as computed by Williams & Hazen formula was 69.69, this being lower than that in the Williams & Hazen tables for pipe 40 years old. From these tests it was evident that the 30 in. line was far below the carrying capacity of new cast iron pipe. A contract was awarded to the National Water Main Cleaning Co. for the cleaning of 6,000 ft. of this 30 in. pipe.

Pipe Coefficient Increased

Similar tests were run after the pipe had been cleaned and the results thereof are shown on Chart No. 1. The average pipe coefficient was brought up to 116, and at low velocities as high as 120. The carrying capacity of this pipe having been restored to nearly that of new pipe. The cleaning of the 30 in. pipe gave such excellent results that

a contract was let to the same company for the cleaning of additional feeder mains into the northeast section of the city; there being 30, 24, 20 and 16 in. pipe lines in this district.

Similar tests were run on each of these pipe lines both before and after cleaning and the results thereof are shown on the accompanying charts. In all of these cases it will be noted that the pipe after being cleaned was restored to carrying capacity and corresponding loss of head as indicated in Williams & Hazen tables under coefficient 120.

In making the test on the smaller lines, we were unable to place the gauging taps 1,000 ft. apart because of service connections and connections at street intersections.

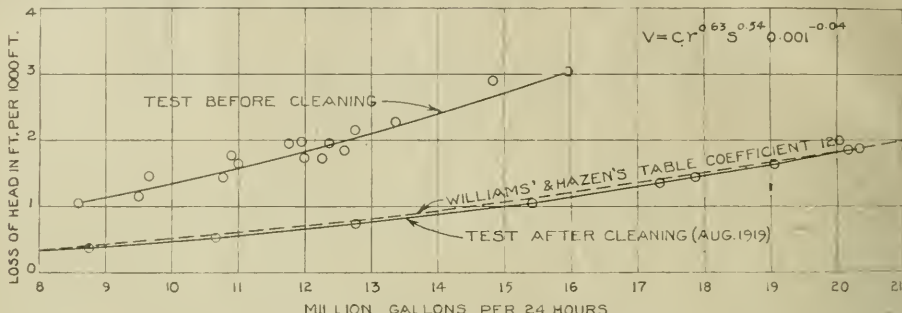


CHART NO. 2—RESULTS OBTAINED AFTER CLEANING 36-IN. MAIN

They were placed at 200 ft., 250 ft. and 500 ft. apart, depending upon conditions encountered.

The liquid used in the differential U tube was a mixture of carbon tetrachloride and bromoform brought to the required specific gravity by the addition of gasoline. The specific gravity was varied in accordance with the variation in distances between taps on the line to be tested so that in each case the readings on the U tube were directly in feet loss of head per thousand feet.

In the spring of 1919, similar tests were made on the 36 in. flow line from the low service station at Quindaro to the Kas River tunnel, a distance of 17,000 ft. It was found that the average pipe coefficient as computed by the Williams & Hazen formula was 71.5 and that by cleaning this line the coefficient was restored to 122.33.

Method of Cleaning Mains

The methods used by the National Water Main Cleaning Co. for cleaning large mains leave for the Water Department no intricate or expensive co-operative work. The section of pipe to be cleaned is valved off and a cut made at each end sufficient to admit entering and removing the cleaning machine. After cuts are made and the machine inserted, the pipe is then sleeved up and the joints poured,

so that it is only necessary to have the main out of service for that length of time. The actual cutting and repairing of the various mains was done by department forces while all of the other work such as excavating, backfilling, placing of machine, etc., was done by the contractor.

Cost of Cleaning Mains

The contractor's price for cleaning ranged from 26 cents per foot for 16 inch pipe to 45 cents per foot for 36 inch pipe and the total cost, including all expenses for operating valves, cutting and repairing pipe and for all necessary sleeves and material was \$22,046.09 for 43,837 lineal feet of pipe cleaned or 50.3 cents per lineal foot for all sizes.

The total cost of cleaning the various sizes including pavement repairs and operation of valves, etc., was as follows:

7,202 ft. of 16 in. pipe—\$2,472.52 or 34.3 cents per lin. ft.
7,280 ft. of 20 in. pipe—\$3,056.80 or 41.9 cents per lin. ft.
3,371 ft. of 24 in. pipe—\$1,813.56 or 53.5 cents per lin. ft.
8,984 ft. of 30 in. pipe—\$5,640.93 or 62.3 cents per lin. ft.
17,000 ft. of 36 in. pipe—\$9,098.28 or 53.5 cents per lin. ft.

Referring again to Chart No. 1, the average flow through the 30 in. pipe from Turkey Creek Station to 17th and Baltimore before cleaning was 11.1 million gallons per day and the friction loss was 4.23 ft. per thousand feet. After being cleaned, with the same quantity of water passing through the pipe, there was a friction loss of 1.6 ft. per thousand feet or a net gain of 2.63 ft. per thousand feet amounting to 57.8 ft. for a total of 6,000 ft. cleaned. This was also checked approximately with pressure gauges at each end of the line and is equivalent to a saving of 1,460 million foot pounds of work per 24 hours. Had this been a line through which we desired to deliver 11.1 million gallons of water per day at a certain head, there would have been an actual saving in coal of \$6.67 per day or \$2,504.00 per year, so that the saving in one year in coal alone almost equals the cost of cleaning.

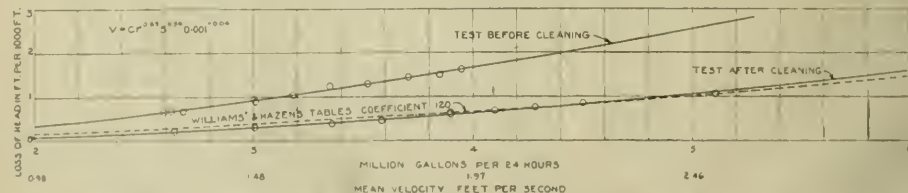


CHART NO. 3—SHOWS INCREASE IN CAPACITY OF 24-IN. MAIN AFTER CLEANING

after which the water is turned on behind the machine. After the machine once starts moving it travels very rapidly through the main (3 to 4 ft. per second), coming out at the open end of the section to be cleaned and bringing all the dirt and encrusting material out ahead of it.

The actual time any section of main is out of service depends almost entirely upon the speed which can be made in making the necessary cuts in the pipe and sleeving them up as the actual traveling of the machine from one end to the other of a section of pipe requires but very little time. Usually the cuts on large mains can be so arranged that they can be made and repaired in approximately 12 hours

Increased Carrying Capacity

However, as we carry a constant pressure of 150 pounds, the cleaning resulted either in increasing the pressure in the down town district 15.7 ft. with the same quantity of water passing through the line or with the same loss of head as before cleaning, the quantity delivered through the line would be approximately 19½ million gallons per 24 hours, or an increase in carrying capacity of 8.4 million gallons per day, or nearly 80 per cent.

To obtain the same increase in capacity as the cleaning of the 30 in. pipe resulted in, would mean the laying of an additional 24 in. feeder main. The estimated cost of such

a line at that time was \$88,800.00 and the annual interest on this amount at 5 per cent is \$4,440.00, making a total annual saving of \$6,944.00, as against a total cost for cleaning of \$3,720.50. In the case of high pressure distributing mains the cleaning of the 26,000 ft. of various sized pipe now enables the delivery to the northeast section of town of approximately 12 million gallons per day more than before cleaning without increased head at the pumping station. Therefore it will be readily seen that the laying of additional feeder mains can be postponed for some time by keeping the present feeder mains up to their maximum carrying capacity.

In the case of the 36 in. flow line, it was found on the test before cleaning that with a loss of 2.7 ft. per thousand feet the line was flowing 16 million gallons per 24 hours. This was practically the maximum amount of water that it was possible to put through this line with the limiting head of 50 ft. on the Quindara pumps. The test after cleaning indicated that with the same loss of head, the capacity had been increased to approximately 26 million gallons or 75 per cent. In other words, this gave the department an increase in flow line capacity of approximately 10 million gallons per day, which was greatly needed during the periods of maximum consumption in the summer of 1919. Under normal conditions of consumption, the cleaning of this flow line actually resulted in a saving of 1.7 feet of friction loss per thousand feet.

Cleaning Does Not Damage Pipes

Inspection of the interior of the mains after cleaning disclosed that the machine had no injurious effect upon the interior surfaces. The springs on the machine are not set stiffly enough to cut into the cast iron and in many instances where inspection was made, it was found that the old coating was still in the grains of the iron. The machine in many instances we sent around sharp curves, some as much as 60 degree bends and also through open gate valves without injurious effect. It cleans the walls of the pipe very thoroughly and leaves it practically as smooth as new pipe.

As to the question of how long the benefits derived from the cleaning of water mains may be expected to last, the author has heard it stated many times that after a pipe had once been cleaned the corrosive effect or the formation of barnacles was much more rapid than before cleaning. In fact, the contractor stated that the carrying capacity might decrease the first year but would be less rapid thereafter. With a view to ascertaining what this effect would be on the 30 in. main, permanent pitometer pits were put in so that tests could be run from time to time after the cleaning. Accordingly pitometer and loss of head tests were run again in the fall of 1920 on this main and the results of these tests are also shown graphically on Chart No. 1. It will thus be noted that two years after cleaning, there was practically no change in results from the test run immediately after the pipe was cleaned. This would tend to indicate that the corrosive action is no faster after cleaning than on ordinary new pipe.

The author believes that in the designing and laying of new feeder mains, serious consideration should be given to the advisability of building permanent pits with removable sections of flanged pipe so that a main can be readily and cheaply cleaned from time to time. It is now the common practice among engineers, when computing the size of pipe required to deliver a certain quantity of water, to use the loss of head figures as given in Williams & Hazen tables under coefficient 100, thus providing a larger size than necessary under coefficient 120. It can be readily seen that the interest on the saving in first cost between the smaller and larger pipe will far more than pay the cost of maintaining the smaller pipe at its maximum capacity by cleaning it whenever necessary. Paper read at the American Water Works Association Convention at Cleveland, June 1921.

VANCOUVER ENGINEERS CHOOSE OFFICERS

THE annual general meeting of the Vancouver Branch of the Engineering Institute of Canada was held in the Auditorium of the Board of Trade on Dec. 21. The result of the ballot for the election of officers for the year 1922 was: Chairman, C. Brakenridge; vice-chairman, A. C. Eddy; secretary-treasurer, P. H. Buchan. The three new members of the executive to hold office for 1922 and 1923, elected in place of the three retiring members of a total of six are: J. N. Anderson, Maj.-Gen. R. G. Edwards Leckie and Wm. Small. Two amendments to bylaws were carried.

CENTRAL HEATING PLANT AT NORTH BATTLEFORD

By M. D. Cadwell
Superintendent of Utilities

CENTRAL steam heating was first introduced into commercial circles in North Battleford in the summer of 1916 when the steam main was laid from the power plant to the new public library which was built that year, located on Main Street, 750 feet distance therefrom. The service was so successful that it was decided to extend the system to serve the business section of the city after the close of the war, provided ways and means could be arranged to finance the initial cost of the installation.

A very comprehensive research was conducted by the superintendent of utilities for a period of nearly four years covering the merits of a central heating plant and its adaptation to conditions prevailing in North Battleford.

In the summer of 1920 it was decided that the proposed installation would prove both advantageous and profitable, and the City Council signified its willingness to proceed at once with the installation, provided the patrons would finance the cost of the undertaking. An advance deposit, representing the fixed figure on a unit basis, and proportional to the requirements of each consumer, was agreed upon, and tenders were called for the supply of necessary material. A part of the installation was made in the fall of 1920, but, due to the lateness of the season, less than ten consumers received service during the season of 1920-21. Meanwhile, materials were received from time to time and in the spring of the present year, practically all supplies necessary for the completion of the system were on the ground.

By the end of September, 1921, thirty consumers were receiving steam service and the installation of the distribution system was completed.

The popularity of the service and the ever increasing demand for steam necessitated the installation of a new and larger steam main to supplement the original one laid down. This installation has recently been completed and was put into operation November 26th.

Amount of Piping Used

The complete installation now comprises 5077 lineal feet of piping arranged as below.

Under Ground Mains

743 lineal feet of 12 in. pipe.
270 lineal feet of 10 in. pipe.
326 lineal feet of 8 in. pipe.
920 lineal feet of 5 in. pipe.
1218 lineal feet of 4 in. pipe.
90 lineal feet of 3 in. pipe.
56 lineal feet of 2½ in. pipe.

Under Ground Services

131 lineal feet of 4 in. pipe.
407 lineal feet of 3 in. pipe.
522 lineal feet of 2½ in. pipe.
147 lineal feet of 2 in. pipe.
98 lineal feet of 1½ in. pipe.

Under Ground Drains

94 lineal feet of 1½ in. pipe.
55 lineal feet of 1¼ in. pipe.

All piping is thoroughly insulated and enclosed in a circular casing manufactured in North Battleford and every lineal foot has been graded with an engineer's level, and all lines set with transit.

Complete and perfect drainage has been provided for all piping placed below the ground level. The estimated life of the plant is 50 years.

The total cost of the system, as installed, was approximately \$35,000. The system was designed by the writer and was installed by the employees of the utilities department under his personal supervision. There are now upwards of 40 consumers with the prospect of this number being increased in the very near future.

During the recent inclement weather, upwards of 150,000 lb. of steam were delivered to the patrons every twenty-four hours. Exhaust steam from the generating units at the power plant is used as the source of heat.

While North Battleford now owns and operates a comprehensive and ideal central heating plant, making it the first municipally owned plant of its kind in Canada to date, it has not cost the ratepayers a single farthing and is greatly augmenting the revenue from the utilities.

The operation of this new utility is being watched by engineers and other interested municipal officials from coast to coast, and it is hoped that the example set will in the near future, result in similar installations elsewhere.

Development of Canadian Railway Construction

Author Describes Early Trade Routes and the Economic Conditions Which Resulted in Construction of Railways in Canada — Problems Solved by Engineers When Locating Trans-Continental Roads

BY H. K. WICKSTEED

Formerly Chief Locating Engineer, C.N.R.

CANADA is a very big stretch of country with a vast amount of undeveloped and only partially developed territory. The older portion tributary to Quebec, Halifax and St. John was comparatively compact and accessible. It had a great extent of sea coast, excellent harbors, and its only exports were fish and furs. The fish, of course were carried on their own element, and the initial fur trade prospered by reason of the watery highways which nature had provided. Furs were enormously valuable in proportion to their weight and even if the lines of communication were much broken by rapids and falls and watersheds, the native Indians had already devised means of utilizing them and evolved the bark canoe, one of the most perfect of semi-savage products. Express freight could be carried in them with really extraordinary speed and certainty into the heart of the continent, on the lakes and rivers of Canada. These are an especial feature of the eastern provinces, covered largely by the Laurentian belt of rocks, an enormous U-shaped formation extending from the Hudson Strait clear around by the Atlantic and the North Shore of the St. Lawrence, the Ottawa and the Great Lakes. From Lake Superior it bends to the northward passing within fifty miles of Winnipeg and then forms the eastern shore of Lake Winnipeg and extends on northward to the Arctic Ocean. The average width of this broken country is 200 to 300 miles. The outcrop first seen and known along the St. Lawrence is very bold and high, high enough to be spoken of as mountains, and the cognomen was derived of course from the river itself. As a matter of fact there are no mountains properly so called, but merely a very broken and wrinkled plateau with a very bold front to the south and east and a much flatter slope to the north and west. The highest elevations we have are in the neighborhood of 2,500 to 3,000 feet and in one or two cases the watersheds are very much lower than this, not much more than 1,000 feet above sea level, but the surface of this plateau is almost incredibly broken up, and the rocks being very hard and compact. The hollows have become filled up with water and the result is some thousands of lakes and ponds, some of them very large, some only a few acres in extent. Of rivers properly so called there are hardly any in some sections, the surplus water dropping from one lake to another over rock ledges, and expanding again. Even the Ottawa draining a very large territory is, except for the last 150 miles of its course, which is just without the Laurentian formation, a succession of lake expansions.

The "Great Barrier"

This rough country has been designated the "great barrier" because it separates the fertile lands of the St. Lawrence valley and the Great Lakes basin from the great central plain of Canada, and it was at one time considered a great obstacle to modern methods of travel, but in these early days of the bark canoe it made these very plains more accessible and even the three uppermost Great Lakes were reached by the Ottawa much more easily and rapidly than by the St. Lawrence. Champlain reached Lake Huron, and the French fur traders following after him reached Lake Superior, long before Father Hennepin first set eyes upon the majesty of Niagara. Verandrye easily crossed the 400 miles from Lake Superior to Lake Winnipeg and established posts which were kept in regular communication with Montreal by canoe, and the generation following him, reached the base of the Rocky Mountains by the Saskatchewan River and the Missouri by marches across the plains from these outposts long before anyone had ascended the river.

From a still more advanced post in the same chain of communication MacKenzie, using the same means of travel, voyaged down the great river which bears his name to the Arctic Ocean and up a tributary, the Peace, to where it breaks through the mountains and down the Fraser to within a few marches of the Pacific Ocean which he reached

long before the Lewis and Clarke expedition by way of the Missouri and the Columbia.

The fur trade was the incentive for practically all this enterprise and exploration, and so far from being a "barrier," this heavily wooded country of lakes and rocks not only supplied the fur but the means of transporting it to the sea and of bringing in articles of trade for barter with the Indians. Even in the depths of a northern winter, communication was not entirely blocked and the same routes followed by Indian runners and dog trains, carrying the mails with wonderful dispatch and regularity over the frozen lakes, when the routes across the prairies were practically closed. The forest furnished fuel for the camp fire and shelter from the bitter winds.

After the fur trade came the timber trade and again this rough country was the principal source of supply, not merely because of the forests with which it was covered, but because the lakes furnished the means of floating it out to the St. Lawrence. If the supply of water was too small to float it from one navigable stretch to another the parent lake was dammed back for a few days or hours and the level raised. Then a sluice gate was opened and the logs were carried through with the rush of water to the next floatable stretch and the operation repeated until a navigable river was reached. All the forest timber was not in Laurentian country, much of it was floated down the St. Lawrence and the Ottawa themselves from other tributary streams, but these natural reservoirs contributed greatly to the ease with which it was floated out from remote districts and to this day while the timber men of Minnesota, Wisconsin and the Pacific coast have been using light railways for a generation or more, those of Northern Ontario and Quebec are still "driving" by water.

Reservoirs of Potential Power

These same natural reservoirs, actual and potential, have of recent years acquired a new value as affording opportunities for the storage of water for power purposes, and as the timber industry has begun to wane in eastern Canada, this "barrier" region has come to the front again as one of the greatest depositories of potential power in the world. Nearly all the tributaries of the St. Lawrence on the north except the Ottawa and the Saguenay have very steep pitches on their lower courses, while the grades of the upper reaches are comparatively flat. Where the fall is greatest the volume is also greatest and these points are also nearest to great centres of population. This is a very happy conjunction indeed; but the run off of the natural streams is very irregular, melting snows in spring often swell the volume to many times that of midsummer, the natural reservoir sites and the hard, impervious rocks make another ideal combination for the storage of water in this region, and by using these opportunities the potential value of the St. Maurice has already been doubled. The Ottawa and the Otonabee have been much improved, and the Winnipeg will soon be one of the great assets of Manitoba. One river, the Nipigon, has in common with the St. Lawrence of which it is the ultimate source, so great a natural reservoir at its head that its flow is almost as regular as that of the great river itself, the latter, however, is not a Laurentian river, although it has given its name to the region of its birth. The "barrier" region again has developed a large amount of mineral wealth: the nickel of Sudbury, the silver of Cobalt, the gold of the Porcupine districts, and the iron of the Messabi and Vermilion ranges. And lastly in certain well defined depressions and on its northern slopes the "barrier" has developed a capacity for agriculture on a very considerable scale, so that all things considered the title of "great barrier" has turned out to be something of a misnomer, although 40 or 50 years ago when the first railway surveys were being made through it it did seem to deserve the name. Early trade, it will be seen, was more fostered by the Ottawa than by the Upper St. Lawrence, but, when agriculture became a recognized industry the greater river

came into play as a means of transport. The lower reaches from Montreal to Prescott were much broken by turbulent rapids and the navigation was arduous and difficult, but once the lake expansions were reached a large portion of the arable lands of the original Upper Canada were within reach of schooner and later, steamboat navigation, with only one break between Queenston and Chippawa, some nine or ten miles, only one portage in 700 or 800 miles. Upper Canada also offered a milder climate than lower, and a very large unbroken stretch of fertile land along the lake and river shores. So that when larger vessels came into use as settlement progressed the Upper Ottawa was abandoned as a principal trade route. The Lower river was a great drawback and improvement became a necessity. Partly as a military measure and partly because it avoided many constructive difficulties on the main river, the Ottawa was improved as far as the Chaudiere Falls, and the Rideau and Cataract Rivers made navigable to Kingston for barges of five foot draft. This was a great improvement, of course, over the "Durham" boats.

An Old Trade Route

Another trade route which led to Lake Champlain and through it to the Hudson and New York was by the Richelieu, a route travelled in the very earliest times by the French to and from the country of the Iroquois and used by them in their raids upon the settlers in and about Montreal. The Richelieu navigation was broken by a long rapid at Chambly, and a minor one at St. Ours, and the very first application of the railway in Canada, was a tramway from the St. Lawrence at Laprairie to the Richelieu at St. John's. This portage railway, not only avoided the broken navigation, but shortened the distance from Montreal to Lake Champlain, by some seventy miles. The next steam railway was another portage railway, from Montreal to Lachine, avoiding the Lachine Rapids, and as a corollary to this, was the Carillon and Grenville, avoiding a series of three rapids on the Ottawa. These two railways in conjunction with two river steamers, permitted a very good service to be established between Montreal and Ottawa, which was kept up until a few years ago, and the trip was made in twelve hours, or at the rate of ten miles per hour.

Owing to the difficult transportation on the river, between Montreal and Prescott, the trade of Upper Canada had been rather with the south shore of the lake, through Rochester, Oswego and Buffalo than with the east. This was brought about by the Erie Canal, opened in 1825. It was only a ditch, with four feet of water, but it was a continuous ditch, carrying barges through from Lake Erie or Lake Ontario to the sea, without breaking bulk and bringing it, moreover, to the sea at a port which was open all the year round, and which had an established import as well as export trade.

Then, as now, the St. Lawrence was the river god of Canada, and Canadians looked to it, not only as a means of carrying their own trade and cementing the bonds between Upper and Lower Canada, but of diverting the trade of the West, of what are now the United States, through Canada to Montreal.

The Welland Canal was built and followed by the St. Lawrence canals, with nine feet draught. The whole was completed in 1848, but in the meantime, the Erie canal had built up cities and towns, and these had, in their turn, built up a railway system between New York and Buffalo, and except for passenger service, the canals were almost useless. The nine foot canal open for only seven months in the year, was obsolete before it was completed. The effort of building this canal was a prodigious one for the time and for a struggling colony of small population, and the disappointment was keen. The enterprise for a time exhausted the revenues and credit of the colonies, and while they began to turn their attention to railways, many schemes were originated, but few came to anything. The early roads, it will be seen, were all of the nature of "portage" roads, bridging gaps in navigation. The Champlain and St. Lawrence, before referred to, was opened in 1837. The Montreal and Lachine, in 1847, and in 1852 it was extended by means of a car ferry across the St. Lawrence to the southern boundary of Canada. In 1854, the Erie and Ontario, from Queenston to Chippawa. A more ambitious scheme, but in the same direction and with the same object was the Northern Railway from Toronto to Collingwood. It was begun in 1851 and opened in 1855. It has been a useful development road, but quite failed as a shortcut from Lake Ontario to Chicago.

Portage Roads

A still more ambitious project had its birth about the same time, that of a winter portage from Montreal to Portland. The St. Lawrence and Atlantic was to be built from Montreal to the international boundary. The Atlantic and St. Lawrence was to meet it there and carry it to Portland. This project worried along incomplete for some years, and finally became part of the Grand Trunk Railway of Canada, in common with the Montreal and Kingston and the Kingston and Toronto Railway.

Another portage road was the Buffalo and Lake Huron, which, however, was a little different from the others, in that it merely sought to carry American traffic to the American roads at Buffalo, en route to New York.

All these roads, it will be noticed, were complementary to navigation. Then, as now, there was a feeling that, in the Great Lakes and the St. Lawrence, Canada, the North American continent, in fact, had a great link between the West and the sea, that should be made use of and from which Canada should derive some benefit. The Great Western was the first which recognized the principle of through long distance haul by rail. New York had a through system to Buffalo. Chicago was the origin of lines coming east to Detroit. The map showed that the shortest connection was through the western peninsula of Canada. The West in those days was the west of the United States. Our own West had no commercial existence whatever. Even the Grand Trunk, although immensely valuable to Canada as a development line, catered to the same trade. The Great Western had already taken possession of the natural route through Hamilton, and the Valley of the Thames to Detroit, but the Grand Trunk was not to be thwarted and built to Sarnia and down the Michigan side of the river to Detroit when, finding its share of the through traffic to be got in that way small, fostered the Detroit and Grand Haven with a car ferry across the Lake Michigan to Milwaukee.

Great Western Railway Built

The Great Western proved a considerable success in its youth and the policy of competition began to take shape, the American roads building a similar cut off, the Canada Southern, between Buffalo and the Detroit river, which avoided the heavy drop from the Lake Erie to Lake Ontario level, and also the steep grades by which this rise and fall was overcome. The Canada Southern was probably the first line located on really scientific principles in Canada, the grades being as low as three tenths of one per cent, and it contributed greatly to the New York Central's attaining the commanding position which it has always held as the cheapest east and west carrier on the continent. In an attempt to bluff the Canada Southern into abandoning its enterprise, the Great Western built its "air line" accomplishing some of the objects of the Canada Southern, but in a much inferior way. The Canada Southern had the advantage of knowing just what its function was with existing traffic to count on and foster. The allied New York Central on the one hand and Michigan Central on the other were lines of exceptionally high standard which it could not consistently underrun, and the country through which it ran was generally a very easy one; but it was never the less a fine piece of work.

The year 1867 was that of Confederation and as one of the articles of agreement with the eastern provinces the Intercolonial was initiated to connect the Nova Scotia system at Truro with the Grand Trunk at Riviere du Loup. The Intercolonial was located and built under the direction of Sandford afterwards Sir Sandford Fleming, and is another consistent piece of work as has been abundantly proved by nearly fifty years of operation. The location was largely influenced by political and military consideration; but it is doubtful even if the Ashburton treaty had given the United States much less of Maine than it did, whether a much more favorable line could have been secured although a shorter one certainly could. The Intercolonial has the advantage of crossing the Appalachian chain at an extremely low point—the lowest between the Hudson River and Gaspe—750 feet as compared with 1,700 on the C. P. R.'s short line and 1,310 on the National Transcontinental, the latter built avowedly as an improvement many years later. This is itself an enormous advantage and in addition, it served a great number of the older settlements of New Brunswick and Quebec which were naturally along the sea-coast.

In 1870 surveys under the same eminent engineer were commenced for the Canadian Pacific a much more onerous and greater task—so much so that an effort was made in

the first case to temporarily evade the construction of a line across the "great barrier" which we have described and dwelt upon and to use as much as possible of the navigable lakes and rivers, and connect these by portage railways as a temporary measure. One amphibious route was actually opened up between Lake Superior and the Red River, using a great number of the Laurentian lakes with wagon roads between them and some hundreds of settlers and their effects were actually taken into Manitoba in this way, but the transport was necessarily excessively slow and cumbersome, and even as a temporary expedient it was soon abandoned.

Birth of the C. P. R.

Construction on what was originally called the Thunder Bay Branch was started in 1874 and completed in 1879. Meantime a branch had been built from Winnipeg to the boundary line at Emerson. This gave a through service all the year round via St. Paul or Duluth, and Manitoba was definitely placed on the map. A start had also been made on the Pacific end and a certain amount of line built through the Fraser canyon. It was supposed from the results of surveys made that the main line would pass far north of Lake Superior — but no definite line was laid down at this time although tolerably complete surveys had been carried across the plains and through the mountains. Progress on actual construction was slow as was the settlement of the western prairie country. The scheme for using the minor water stretches had to be abandoned and it became evident that the only thing which would satisfy the needs of population and bind the new Confederation together was a through rail communication from one end of the country to the other, which would be serviceable during the entire year. British Columbia was grumbling about its not being nearer to accomplishment and yet it was a tremendous undertaking for a small population to undertake. Attention was again turned to the possibility of enlisting private enterprise, as in the case of the Grand Trunk and aiding it by concessions of land as had been done in the case of the Union and Central Pacific. A tentative arrangement with Sir Hugh Allan and some associates developed into the famous "Pacific Scandal" and the overthrow of a government and a delay of several years but it soon came into power again, and a new syndicate, a combination of capital, railway experience, and political acumen, came into existence. The railway experience was that of J. J. Hill, the man Canadian, the experience that of the new west of Minnesota and Dakota. The capital was represented by George Stephen, now Lord Mount Stephen and the political manipulation by Donald Smith, afterwards Lord Strathcona.

There were many stormy debates in the Canadian House of Commons when the question of the "great barrier" and its avoidance was very much in the foreground; but in the end the deal was consummated and it was probably on the whole a very good bargain for Canada. The contract was ratified and signed in February, 1881.

Problems in Locating the C. P. R.

One of the points in discussion was whether the line should not go south of Lake Superior instead of north, crossing the boundary at Sault Ste. Marie. In the end both lines were built and the question of a direct route through eastern Canada itself was never in doubt. Callander, at the east end of Lake Nipissing was fixed as the official eastern terminus and the old route of the early explorers and fur traders, the Valley of the Ottawa, became once more the national highway from the Atlantic to the West. J. J. Hill very early dropped out of the combination; but in William Van Horne the new company secured a general manager, an even greater genius, and who became one of the most notable of Canadian citizens as well as its foremost railway magnate. Under his direction construction was pressed forward at a pace unprecedented in Canadian annals, and a direct route along the immediate shore of Lake Superior which had been reported to the government as impracticable, was proved not to be so, and was adopted. I, personally, had very much to do with this demonstration of practicability, and I believe that under the circumstances the choice of route was a wise one. It introduced some 80 miles of very heavy work; but the heavy work was close to the beach of Lake Superior and could be reached very readily by men and supplies. As the company was bound to time as well as not overburdened by financial resources this was a very important consideration. In the second place it avoided the overlapping of the Thunder Bay branch by the main line for some 200 miles as contemplated by Mr. Fleming and made this branch

actually part of the main line, utilizing to the fullest what the government had completed. This represented a great saving in initial cost and operation, although the through distance was somewhat longer. The standard of grades and curvature was somewhat lower than that Mr. Fleming had originated and intended to carry through; but this was not felt until some years later and it was quite up to the average of American roads. West of Winnipeg the route was also much altered. Mr. Fleming had practically chosen the Yellowhead pass through the Rockies, partly on account of its much lower elevation than that of anything to the south, partly because the route of it across the plains lay through very much better country as it seemed for settlement, avoiding the crossing of a corner of the Great American Desert, which jutted in from the south.

C. P. R. Route Through the Rockies

The Canadian Pacific preferred a more southerly route, first because it was shorter, on the map, at any rate, second because they feared invasion from the south by American lines. The country to the north would be completely at their mercy for a great many years to come as far as east-bound traffic was concerned. The pass chosen was the Kicking Horse, much higher than the Yellowhead, but remarkably easy of approach from the east and not very difficult from the west. The really weak point as compared with the Yellowhead was that while the latter provided for an almost continuous descent from the continental divide to the Pacific, the Kicking Horse route opposed several intermediate ones. The most important of which is the Rogers Pass through the Selkirk. This involved a secondary rise of 1800 ft. from the valley of the Columbia to an elevation of 4300 ft. or only 1000 ft. lower than the main divide. This has since been lowered to 3800 ft. by the construction of the Connaught tunnel, five miles long. The Eagle Pass through the Gold Range and the Notch Hill summit are comparatively insignificant, but troublesome nevertheless. The ruling gradients of the line were much below those which had been demonstrated to be feasible further north, and contemplated by Mr. Fleming. One per cent was carried across the plains and to the summit, and through the mountains the standard of the American lines was adopted, 2.2% or 113 ft. per mile. Mr. Fleming's idea was to build a line which would be superior to all other lines, either existent or which could be expected to be built for a very long time, a line which would be equal to the requirements of the distant future. It is the engineer's usual point of view and when funds are plentiful and prospect of traffic abundant it is a justifiable point of view. Van Horne on the other hand was an operating man. His idea was to construct a development line good enough for the purpose with the means at his disposal and in the shortest possible time, and to improve it afterwards as traffic grew. Even from his own point of view the line is by no means perfect, but the sequel has shown that his principles were sound. Cheaply built as much of the line was, it was a hard financial struggle to get it completed and taxed the resources of the promoters very severely, and even after its completion in 1886 it had a hard time to make line depending on foreign roads to take care of its traffic both end meet. Van Horne knew that a transcontinental in the east could hardly be expected to pay its way and he began early in the game to provide branches and collecting lines to give the Canadian Pacific its own entry to the principle centres. Two minor lines, the St. Lawrence and Ottawa, and the Brockville and Ottawa built originally in the interests of the Ottawa lumber trade were acquired. Also a branch of the latter, the Canadian Central, and the Brockville and Ottawa was extended from Sand Point through Renfrew and Pembroke to Callander. This gave an eastern extension to Ottawa and at the same time shut out the Grand Trunk from Ottawa.

The Northern Colonization and the North Shore Railway consolidated under the title of the Quebec, Montreal, Ottawa and Occidental gave it an entry both to Montreal and Quebec. The Kingston and Pembroke commanded Kingston and an auxiliary new line was built under the title of the Ontario and Quebec from Montreal to Toronto via Peterboro. The Credit Valley carried it on to St. Thomas and from a point on this the South Ontario Pacific carried it through London and Chatham to Windsor. The Toronto, Grey and Bruce gave a line to Georgian Bay at Owen Sound and a steamship service gave a summer direct route from Toronto to Fort William. Montreal and Quebec were not winter ports, the Grand Trunk's terminal, Portland, was, and the C. P. R. was not content without its own

approach to the sea. This was accomplished by building from Montreal to Sherbrooke. The acquirement of the International to the Maine boundary and a new line across the centre of the state to the New Brunswick boundary and by existing lines to St. John.

C. P. R. Extends to the Soo

In Northern Ontario the "Soo" branch was built from Sudbury to a connection with the St. Paul, Minneapolis, and Sault Ste. Marie at the latter point. In a very few years the Canadian Pacific had not only built a transcontinental line, but an eastern system covering nearly all the principal points in Ontario and Quebec. The Grand Trunk had, of course, fought hard. It had tried hard to head off both the Soo branch and the Toronto and Ottawa, but it was badly handicapped by an absentee directorate which not only could not act promptly in an emergency but owing to distance could not even appreciate the nature of the emergencies. It did, however, forestall the C.P.R. by extending the Gravenhurst branch of the northern which it had acquired years before, to Callander and North Bay, and secured for itself the all-rail connection between Toronto and the West. After some years of misfortune and discouragements due to grasshoppers, the prairie country began to prosper and grow in population, but with prosperity came discontent and dissatisfaction with rates and service, and it clamored for a new outlet to the sea.

Start of Canadian Northern Railway

The Hudson Bay Railway was much mooted but the scheme did not tempt capitalists and the government did not want any more railway building and out of this discontent grew the Canadian Northern. Two men, both sons of farmers in older Ontario who had successfully carried through several railway contracts on the Canadian Pacific acquired a charter in central Manitoba and built a short line from the existing system northwesterly to Dauphin. Instead of offering it for sale they elected to retain and operate it for a time and in the first year of its operation rather to their surprise it paid its way. Another charter, the Manitoba Southeastern, was acquired, as also the Rainy River, and they conceived the idea of building a new line to Lake Superior, and in 1898 work was started at both ends and after a hard struggle completed three years later, then came a great opportunity. The Northern Pacific had crossed the boundary and built up a considerable system in Southern Manitoba. The parent line was in financial trouble and it was arranged that the province should lease these lines and re-lease to one or the other of the existing lines to Lake Superior. The Canadian Northern secured them and not only did it become the third largest system in Canada but Manitoba and the territories secured the competition for which they had been agitating.

In 1902 the Canadian Northern had nearly 1300 miles in operation extending from Lake Superior into Saskatchewan with numerous feeders, the idea of a second transcontinental line began to take shape, and attention was turned to the east. The Great Northern of Canada from Hawkesbury to R. a Pierre with connections over the Quebec and Lake St. John to Quebec and the Saugeenay district was acquired. The Inverness and Richmond, a coal road, and the Halifax and Southwestern were built with provincial aid in Nova Scotia. A start was made on the James Bay railway from Toronto to Sudbury, besides numerous extensions in the west. In 1906 surveys were started on the final connecting links east of Port Arthur and soon afterwards a connection was established between Toronto, Ottawa and Montreal. The final gap east of Port Arthur, 600 miles to Sudbury, was not closed until 1914, and the last link of all in the transcontinental chain through the Yellowhead Pass and the Fraser River canyon to Vancouver was not forged until 1916; an extraordinary effort in the face of war and other conditions which had arisen in the preceding ten years.

Beginning of Grand Trunk Pacific

Among these conditions was the fact that the Grand Trunk having realized the bad policy of overseas direction and control, had placed in charge a local president in the person of Charles M. Hayes, another American railway man who was competent both to size up situations and act on them. He recognized at once that the Grand Trunk had lost its opportunity and had been badly handled but he started somewhat too late to remedy the mistakes of the early policy. He would have entered into an alliance with the Canadian Northern providing for the use of that sys-

tem in the west, of the Grand Trunk in the east, and a joint section between Port Arthur and North Bay, but apparently no satisfactory terms of agreement could be arrived at. Such an understanding would have altered the economic history of Canada. Failing this a scheme was evolved with the government for the construction of an entirely new line to be called the Grand Trunk Pacific. The Grand Trunk would have been satisfied with a line from North Bay westerly and so would Ontario and all the Western provinces; but politics unavoidably came into a question of such magnitude and the east strenuously objected to government assistance of great amount being given to a line with an American winter port. Quebec wanted its northern territory developed and that western traffic should at least be carried past its capital city, and the result was that the transcontinental project was tacked on to the Grand Trunk's scheme, and the operation of it made part and parcel of the contract. The addition involved an enormous bridge over the St. Lawrence and not content with this a new line was built between the terminals of the Intercolonial at Moncton and Quebec, the excuse being that the latter was far too long and the grades too steep for economic operation and inconsistent with the requirements of a modern, first class railway. As a matter of fact the saving in distance is trifling, only some forty miles, and it was found necessary to break up the high standard of gradients while the total amount of rise and fall is much in excess of that on the Intercolonial. So that the ultimate operating cost will probably be higher than on the older road with some small improvements.

The Grand Trunk Pacific parallels the Canadian Northern from Winnipeg to and through the Yellowhead Pass, and then branches off to the northward while the Canadian Northern turns south down the North Thompson. There was some excuse for the line through northern Quebec and Ontario. As a colonization line it is proving its value, but colonization lines are not built on the scale that this one was, costing \$110,000 per mile. There was an excuse perhaps for the Quebec bridge for it had long been in the minds of the Quebec population. There seems from an economic point of view to be no excuse for the wholesale paralleling through the western provinces and to a lesser extent in the province of Quebec, of lines which had been encouraged and aided by the Federal as well as provincial governments. Admitting that a single line would eventually have been insufficient for the combined needs of the two systems, a second track would have cost very much less even than the first and quadrupled the capacity while the second line merely doubled it. It would have lowered the cost of transportation and probably resulted in reduced rates which was the great aim and object of the prairie country when it voted its aid. It was well within the power of the government to have avoided this paralleling of lines, which by the way is not to be found only in Canada.

Competition Between Three Roads

As things turned out the war of competition between three rival corporations became a war almost of extermination. Two of the competitors, both of which had been of great service in the development of Canada, have been practically wiped out. The third although too firmly entrenched before the fight commenced to be crippled, has been seriously injured.

There is abundant food for thought in the present railway situation in Canada. It is popular to blame individuals and corporations for their greed and selfishness in situations such as this. It is popular to blame governments for their unwisdom and short sightedness, sometimes they are accused of dishonesty, but it is the people themselves who clamored for the competition and encouraged it. It is the people who elect the government from among themselves and practically dictate their policy and in the final analysis it is the people who pay the piper when things go wrong. We all believe that the National consciousness is honest and sound but how many of the ordinary voters, how many of the members whom they elect understand ordinary questions of economics let alone the complicated fiscal questions of railway construction and operation. In short how many of us are fit to be trusted with the management of our own savings, the surplus product of our own industry.

At the present time the cry is public ownership, and 22,000 miles of our railways are now publicly owned and operated. The staff appointed to operate them is of unquestioned honesty and ability, and if let alone it seems certain that they will earn a handsome surplus over their expenses, that they will eventually earn the accumulated

interest on their cost seems too much to hope for, but how long will the management be let alone? Parliament has already shown a disposition to interfere in matters of detail.

Independently of the question of public or private ownership which is much before the public in these days, there are some interesting comparisons to be made between the procedures in the case of the building up of the several systems. The Grand Trunk was built by English contractors and engineers. The difference between an English road through thickly settled country with traffic waiting to be carried, and a development road through a new country of sparse population was not at all understood and money was lavishly spent. The line was too costly for its function as a development road.

Difference in Methods of Construction

The common stock bought in good faith and paid for was buried under subsequent issues of debentures and first, second and third preference shares and never paid a dividend even when the road was making good earnings. The Canadian Pacific under somewhat worse traffic conditions but riper experience, was built with extreme frugality, even parsimony, with timber trestles, scant ballast, sometimes no ballast at all, sharp undulating grades and somewhat rank curvature. It was some time before it paid a dividend but when it did have surplus earnings there were scarcely any securities senior to the stock and reconstruction was commenced almost at once.

The same frugal policy in construction was pursued in the case of the Canadian Northern and the initial bonded debt in the West was for a long time only \$13,000 per mile. As the road became longer and its future more assured this was increased, but for another term of years it was only \$26,000. The expensive conditions under which the mountain section was built led to an increase, but there was at the same time a very much increased potential earning power. The Canadian Pacific was unique in depending for capital almost exclusively on stock which it scattered broadcast over the world. The Canadian Northern was equally singular in marketing no stock at all and depending on guaranteed bonds bearing low interest. The Canadian Pacific was a great financial success. The Canadian Northern has pretty well proved that it would have been a great success but for a combination of adverse conditions piling up just before and after completion.

The Transcontinental and Grand Trunk Pacific, built under the precisely opposite policy of lavish expenditure and permanent work, have so far been so busy trying to meet even their operating expenses that the question of fixed charges has hardly been considered as yet.

There is still much to be done in Canada. Far as we have got to the north with our development we find like older explorers that the point we last reached is not the limit of habitable country. Stefanson claims that it reaches well to the Arctic ocean and perhaps into it; certainly he shows conclusively that we shall not find appreciably lower temperatures than we have reached for instance at Long Lake 55 degrees Fah. Nor do we have to fear any heavier snowfall than in the Rockies. We have still to build through the Peace River pass and on to the Yukon, down the Athabasca and Slave at least as far as Fort Smith. In the Peninsula of Labrador are enormous mineral deposits and we shall have to go after them but it is probable that our mileage will henceforth increase more slowly and it is to be hoped more carefully than of late years. We shall probably go in more for improvement of existing systems, consolidation and in some cases I trust elimination, improvements in grades and curvature and probably as traffic grows denser and capital cheaper, into electrical propulsion.

Railway Policy

It has been our policy on this Continent to build lines of communication in advance of settlement. The policy has proved a good one up to a certain point and in moderation but it may be and has been overdone and especially has it been proved unwise to build high class expensive lines which can have for many years at any rate only low class functions to perform. Canada for some years was very prosperous, easy money begot expensive tastes and standards, and this tendency to extravagance extended to our railways. Our mileage has not only increased much faster than our population, but our costs per mile have increased rapidly at the same time. I think too that we have given perhaps undue weight to the needs of the great wheat growing belt in the heart of the continent and its necessities for export facilities. As population grows, we shall probably find as the

United States did, that we need a larger proportion of our own food products within our own borders and have less to spare for foreign countries; that the older eastern provinces and the wonderfully rich one in the extreme west will be the principal and most profitable markets for the cereals of the central provinces, and that such export that goes on will be more and more through the western gateway on the Pacific which is open for the entire year. The wonderfully easy grades of the Canadian National lines, as compared with the American contribute support to a development of this kind. The development in the United States has taken similar lines and the Central Plateau being shut off by high mountain ranges from both oceans is finding an outlet to the Gulf of Mexico at New Orleans.

All modern roads lead to the sea as the ancient ones did to Rome and closely related to the railway development of the central plains of the continent is the colossal one of bringing the sea itself nearer to the heart of the continent of giving ocean navigation a chance to walk up stairs to the suite of apartments provided by the upper great lakes of the St. Lawrence chain through the original prehistoric outlet by the valley of the Ottawa, which is all Canadian, or the more modern one which it now uses, which is international.

I have spent much time and thought on this problem in the past but it is beyond the scope of this paper and as I think our financiers will say, beyond the means of our \$ or 9 millions of people at the present time, loaded as they are with a very serious debt.

I think, however, that it is safe to say that if the boundary between two English speaking peoples had not been so absurdly placed in the East, it would long ago have been solved and the carriers of the Great Lakes would have had access to the sea and picked up jobs on the Atlantic in winter instead of lying idle for 5 or 6 months in the year in icebound ports, but it must be borne in mind that the question is an international rather than a Canadian one, and less of Canada than the United States.

Writing editorially some years ago on the Georgian Bay Canalization Scheme, A. M. Wellington, one of the ablest of American engineers used these words: "Our belief that the Ottawa River affords the best opportunity in the world for a well planned ship canal is a fixed one and we should be glad to further it by any means in our power but under present circumstances with one country (the U.S.) to reap the chief benefit and the other (Canada) to pay the cost what is the use. Had the route been in United States territory it would long ago have been built and thrown open to the world as an international highway." The same arguments apply to the St. Lawrence improvement. The interest which the great cities of Chicago, Milwaukee, Detroit, St. Paul, Minneapolis and Duluth and their tributary territory have in the Navigation Scheme is huge compared with that of our sparsely populated northern Ontario. Toledo, St. Louis and Kansas City have shown an appreciation of their interests—our own west has displayed practically none but has forced the government to try doubtful experiments looking to a seaport at Hudson Bay. A great circle through Saskatoon and Liverpool looks almost as well on the map as does one through Liverpool and Kansas City. Physically both schemes are practicable, commercially, the first is questionable to many minds. The difficulties in the second are mainly political, but both are open to the objection that the seaports to be used are ice bound for a great portion of the year.

Fresh in our memory are the experiences which Russia had with Archangel and the Neva and the opening of a new port on the Arctic Ocean. Only a little more remote is that with Vladivostok and the struggle with Japan for Port Arthur and the Manchurian branch of the Siberian railway. Paper read before the Engineering Section of the American Association for the Advancement of Science, Toronto meeting, Dec. 26-30, 1921.

With the Chippawa-Queenston power development officially opened, the Provincial Hydro Commission will forthwith give notice to private companies from which it is receiving power supply of termination of contracts. Sir Adam Beck, in his address at Chippawa recently, announced that the new supply would permit of the practically immediate cutting off of over 50,000 horsepower orders, such power supply to be replaced by that generated by the Chippawa. In the same connection he paid a tribute to the United States privately-owned concerns which had on various occasions rendered assistance to the Hydro.

ENGINEERING SECTION, A.A.A.S. DISCUSSES MANY TOPICS

Four-Day Meeting in Conjunction With Society for the Promotion of Engineering Education—Subjects Considered Include Natural Resources, Mining, Stress Analysis, Ice Prevention, Standardization, Railways, Power Development and Education

FOR four days, from December 27 to 30, the Engineering Section of the American Association for the Advancement of Science, with the co-operation of the Society for the Promotion of Engineering Education, was in session at the University of Toronto. In recent years the Engineering Section has been more or less dormant, its members apparently preferring to confine their activities to the great national engineering societies. However, through the enthusiasm of the local committee of the A.A.A.S., this section was revived and at most of the seven sessions held, the attendance was close to one hundred. All sessions but one were held in the Electrical Building of the University of Toronto.

Natural Resources of Canada

At the opening session on Dec. 27, Sir Clifford Sifton, formerly chairman of the Commission of Conservation, spoke on "Natural Resources and National Welfare." He expressed some anxiety concerning the fuel situation in this country, especially since the known supply of anthracite in the United States will last only 80 years. Sir Clifford advocated the coking of such Nova Scotia and Alberta coals as were suitable, pointing out the value of the by-products, gas, benzol and sulphate of ammonia. He thought that our peat deposits would yet be found of value when a real effort had been made to utilize them.

Optical Stress Determination

Following the opening address, Paul Heymans, who has been a co-worker with Prof. E. G. Coker of University College, London, and who is at the present time installing equipment at the Massachusetts Institute of Technology for stress measurement by means of polarized light, spoke on "Ontario Determination of Stress Distribution in Engineering Problems." By the aid of an unusually fine series of colored slides, Mr. Heymans showed the true variation of stress in members of various cross section and in truss members due to secondary bending. Comparison with the stresses as commonly calculated showed the great importance of some method of determining stresses more accurately.

The Tuesday session was concluded by a paper by Prof. Charles Mannebeck, of the University of Louvain, Belgium, on "Return Current Along Submarine Cables."

Ice Formation and Prevention

Opening the session on Wednesday, Dec. 28, John Murphy, Electrical Engineer for the Department of Railways and Canals, Ottawa, described with the aid of moving pictures, "Ice Formation and Prevention, with Special Reference to Frazil and Anchor Ice." Mr. Murphy advocated the introduction of sufficient heat to the metal parts of hydraulic installations to keep their temperature a small fraction of a degree above 43 deg. F. This, he contended, would be sufficient to prevent frazil clinging to them and would obviate the closing down of hydraulic plants due to ice troubles. His own experiences at Ottawa were cited as proof of his contention.

Engineering Standardization

"Engineering Standardization" formed the subject of the address which followed, given by R. J. Durley, secretary of the Canadian Engineering Standards Association. This paper will appear in an early issue of the Canadian Engineer.

Mining in Canada

Wednesday afternoon, Dec. 28, was devoted to papers and addresses on mining subjects. John E. Hardman, consulting mining engineer, Montreal, spoke on "Fifty Years of Progress in Mining in Canada;" Thos. W. Gibson, Deputy Minister of Mines of Ontario, spoke on "Metal Mining in Canada;" A. F. Brigham, general manager of the Hollinger mine, spoke on "Gold Mining in Ontario;" and W. L. Dethloff, chief engineer of the Mond Nickel Co., spoke on "Nickel Mining and Smelting". The last three addresses were illustrated by moving pictures.

Toronto Harbor Development

Geo. T. Clark, chief designing engineer of the Toronto Harbor Commission, opened the session on Thursday with an illustrated address on "Toronto Harbor Development."

R. A. Ross, chairman of the Honorary Advisory Council for Scientific and Industrial Research, followed with an address on "Industrial Research." He traced the development of the work of the council since its formation in 1917 and explained the means by which the problems of manufacture are being sought out and made the basis of research. The studentships, fellowships and bursaries have grown, said Mr. Ross, from 7 in 1917-18 to 46 in 1921-22. Effort is being made to bring about the establishment of a research institute at Ottawa, so that the work may be extended and made more effective for industrial development in this country. The speaker outlined some of the difficulties that had been experienced in the utilization of lignites, instancing in particular the carbonizing problem.

Railway Development in Canada

At the afternoon session, H. K. Wicksteed, formerly chief locating engineer of the Canadian Northern Railway, spoke on "Railway Development in Canada," tracing the building up of our railway system from the initial pioneer lines to the present time. The superiority of grades on our western mountain divisions, as compared with those on the rocky mountain divisions of the United States transcontinental lines was pointed out by the speaker. Mr. Wicksteed's paper appears in this issue of "The Canadian Engineer."

During the afternoon session two addresses on mining subjects were given, one by A. M. McQueen, vice-president, Imperial Oil Co., Toronto, on "Exploration for Oil in Western Canada," and the other by James McEvoy, consulting coal mining engineer, Toronto, on "Coal Mining in Alberta."

Hydro Power in Ontario

The proceedings for Wednesday were concluded by an illustrated address in Convocation Hall by Sir Adam Beck, chairman of the Hydro-Electric Power Commission of Ontario, on "Hydro-Electric Development in Ontario." Sir Adam paid a tribute to the services rendered to the province by the investigators and engineers with whom he had been associated. He contrasted the state of electric transmission when the first developments were made at Niagara Falls, with that now existing. Energy was now being transmitted economically, said he, 254 miles from the Falls to Windsor.

The saving to the people of Ontario brought about by the development work of the "Hydro" was graphically presented by Sir Adam. While in Windsor, power is available for not over 3½ cents per kw.-hr., and if a certain amount be used, for 1½ cents, in Detroit the rate is 8 cents for steam-generated electricity. In Toronto, the average cost of electricity per month in the 60,000 homes served is 87 cents.

Engineering Education

The opening address on Friday was an illustrated one by D. B. Dowling, of the Geological Survey of Canada, on "Engineering Features of the Development of Mackenzie Oil Field."

Following Mr. Dowling's address, the remainder of the day was devoted to a consideration of the problems of engineering education.

R. C. Harris, Commissioner of Works, Toronto, opened the discussion by an address on the "Relation of Industry and the Practicing Engineers to Engineering Education." President Chas. S. Howe, of the Case School of Applied Science, Cleveland, occupied the chair at this and the succeeding sessions.

Mr. Harris stated in opening that as a result of his somewhat extensive experience with engineers, he had come to the conclusion that they were in general deficient in business training. The engineer is frequently unable to relate the creation of physical things to the value of the dollar. He should make the highest type of administrator, but because of insufficient instruction, or some other reason, he is disposed to confine his attention too much to the physical aspects of his work. On the contrary, he should regard himself as a trustee for the physical and financial welfare of his fellows. The engineer does not study human problems sufficiently, said Mr. Harris. Not often is he able to predict with certainty what given people will do under a given set of circumstances. He regards himself too much as a builder and not enough as a solver of economic and human problems.

Certain desirable characteristics of engineers were outlined by Mr. Harris. The engineer should have courage. Engineering failures sometimes occurred, he said, through the engineer giving the client what he wanted rather than what the engineer knew to be necessary. He should

have initiative, he should be positive rather than neutral, should have foresight, be willing to delegate authority, able to assume large responsibilities under emergency conditions, be public spirited and a social factor in his community.

Mr. Harris suggested that the training of engineering instructors might be greatly furthered by the provision of opportunities for travel and contact with the leaders of the profession in other parts of the world.

Dean Mitchell, of the Faculty of Applied Science and Engineering of the University of Toronto, in commenting on Mr. Harris' address, stated that members of the staff of the University of Toronto were encouraged to cultivate outside interests.

Industrial Viewpoint

S. B. Chadsey, of the Massey-Harris Co., supported the view of Mr. Harris that the average technical graduate was inadequately equipped to deal with the varied economic and social conditions with which he is likely to be confronted. He regarded the graduates as remiss in that they seldom stated frankly to the engineering college the essentials for the success of graduates in the pursuit of their profession.

G. W. Winckler, Toronto, advocated the granting of sabbatical weeks to engineering instructors to improve their knowledge and give fresh contacts and enthusiasm.

Prof. R. W. Angus, of the University of Toronto, expressed doubt of the practicability of teaching very young men in college such things as ruggedness of character and ability to act with wisdom in an emergency. He advocated the more extensive contact of a teaching staff with the outside business world.

Prof. Ernest Brown, of McGill University, stated that McGill had introduced instruction in economics some years ago with satisfactory results. Engineering courses in Canada should be, said Prof. Brown, previously technologic. This type of equipment was of immediate value on graduation, but as time went on, the engineer's work became more and more of a business character, being in the case of some consulting engineers only 20% technologic. The speaker believed that engineering college training should be of such general and basic character as to fit men for many kinds of work. The exact subjects of study do not much matter, Prof. Brown said, if the student is able to sharpen his mental tools thereby.

H. W. Bibber, Massachusetts Institute of Technology, advocated the more careful selection of students on entrance to engineering colleges. The social qualities, he thought, were best brought out in college by college activities.

President Howe stated that at the Case School of Applied Science, the men who employ engineers were called in and questioned concerning the character of the product desired.

Engineering Education for the Industries

At the opening of the afternoon session on Friday, a paper by Prof. Charles F. Scott, President of the Society for the Promotion of Engineering Education on "Professional Engineering Education for the Industries" was read by Prof. C. R. Young. The text of this paper will appear in an early issue of "The Canadian Engineer."

Julius M. Williams, member of the Board of Education, Hamilton, in commenting on the paper, pointed out that the owners of business were frequently uneducated men and that there was a certain prejudice against the claims of the educated man for preierment in industry.

President Howe expressed the fear lest the present trend toward the adoption of courses in business had been stration might be overcome. Courses in business had been introduced at Case School, he said, to give the student some conception of the nature of the business situations he would have to deal with, rather than to impart much detailed instruction. Such was desirable he thought, since a large proportion of engineering graduates became executives after they have been on 15 or 20 years.

Prof. Peter Gillespie, University of Toronto, questioned the wisdom of the engineering colleges, taking the time to instruct a student how to dictate a letter. He thought that the time must be spent to better advantage in giving instruction in subjects that required real mental effort.

Engineering Education vs. Vocational Training

On the conclusion of the discussion of the previous paper, Dr. F. W. Merchant, Director of Industrial and Technical Education, Province of Ontario, addressed the meeting on the field of the technical schools of Ontario and their relation to the work of the engineering colleges.

After clearly describing the nature of the work carried on in the technical schools, Dr. Merchant assured his hearers that there was no overlapping whatever, between the technical schools of Ontario and the engineering faculties of the universities. There is no counterpart in Ontario to the polytechnic and technical institutes of the old world and of the United States. The legislation governing technical education in the province, Dr. Merchant asserted, provides that the technical schools shall not undertake engineering courses of the type offered in the universities.

The product of the technical schools would be concerned, said the speaker, with operation and maintenance rather than with design on construction. He thought that such schools formed an admirable selective agency for the engineering colleges, and that the courses offered provided a good training for entrance to the universities. As an instance of the excellent performance of technical school graduates in engineering courses.

Dr. Merchant cited the case of the thirty men from the Central Technical School in Toronto who entered upon engineering courses in the University of Toronto in the autumn of 1920. Of these none failed and the average standing attained was very high. He advocated the recognition of the practical work in technical schools for university entrance, as equivalent to one foreign language, on the same basis as practical work in commercial schools is recognized for admission work in university commerce courses.

President Howe stated that while the general opinion in the United States appeared to be favorable to the strictly academic qualification for entrance to engineering colleges, the candidates from the technical schools often did very well.

Gaps in Industrial Education

In a paper by Prof. Dugald C. Jackson, of the Massachusetts Institute of Technology, which was read by Prof. C. R. Young following the discussion on Dr. Merchant's address, it was pointed out that in the United States there was a gap in industrial education between the elementary trades schools and the professional engineering schools of university grade. "It is imperative," said Prof. Jackson, "to give to thousands of young men who are to make the bulk of the corporals and sergeants of industry that character of training which makes for self-support in the industries." There must, however, be a clear distinction between trades and education and the theoretical and advanced education of men planning to join the engineering profession. The grade of the trades school cannot be exalted without losing its clientele, while the schools for training young men for becoming professional engineers should be of university rank. Continuing, Prof. Jackson expressed the view that "powers of exact mental analysis of problems when the facts are exactly related and beyond that the powers of accurate synthesis are essential to creative industrial practice, and education that does not provide for sound, deep and broad study of scientific theory is inadequate for the industrial engineers who are to become creative leaders."

President Howe, in discussing the paper, outlined the effect of entrance conditions on the performance of students in engineering colleges in the United States. At Case School, he said less than 50% of those who registered actually graduated, more men leaving at the end of the first year than at any other time.

Prof. E. Brown, of McGill University, stated that in McGill a considerable number of unsuitable students had to be cleared out of the first year at Christmas.

Dean George B. Pegram of Columbia University School of Engineering, described the nature of the selection of students at Columbia, pointing out that with a six-year course most of the elimination was likely to be done before men reached the strictly engineering part of the courses.

The concluding function of the convention, so far as the Engineering Section was concerned, occurred on Friday evening when a joint dinner with the Geological Section and with the Society of Promotion of Engineering Education, the Engineering Institute of Canada (Toronto branch), the American Society of Mechanical Engineers (Ontario branch), the American Institute of Electrical Engineers (Toronto Branch), the Canadian Institute of Mining and Metallurgy (Toronto branch), and the Society of Chemical Industry (Toronto branch) was held.

Arrangements for the meetings of the Engineering Section and of the Society for the Promotion of Engineering Education were made and carried out locally by a committee of J. B. Tyrrell (Vice-president of the Engineering Section and chairman at the meetings), Prof. Robert W. Angus, Prof. Peter Gillespie and Prof. C. R. Young (S.P.E.E.)

ADVANTAGES OF HYDRATED LIME IN PAVING CONCRETE

Has Water-tightening Properties and Increases Density of Concrete. Makes Placing Easier

By Tyrrell B. Shertzer

Construction Engineer, New York City

AMONG the most important properties which concrete should possess, when used as pavement foundation or highway wearing surface, are:

First: Ease of placing, to reduce costs.

Second: Density, in order that the internal stresses caused by expansion and contraction due to varying moisture content may be reduced to a minimum.

Third: Strength to resist the wear of passing vehicles and the impact, more particularly that caused by heavily loaded trucks which are using the streets and highways in ever increasing numbers.

The foregoing are dependent upon the preparation of the sub-grade, provision for drainage, fixing of grades, etc., all of which, although subjects of considerable importance, will not be discussed.

"Ease of Placing" involves many considerations and does not mean necessarily the laying of the concrete after it has been deposited upon the sub-grade.

One of the most recent innovations, is the adoption of the central mixing plant. Time does not permit of a dissertation on the advantages and economies of this system which is really the second step in ease of placing, the first step being the design and equipment of the storage yard.

Lime in Central Mixing Plant

When the central mixing plant was first used, considerable difficulty was experienced, due to the unmixing of the concrete by the jarring and vibration of the transporting vehicles. This resulted in a stratification of the concrete, the coarse aggregate settling to the bottom and the other ingredients separating in superimposed layers in the order of their fineness; the top of the mass being composed largely of cement and water. This unmixing caused the mass to stick in the vehicles, so that frequently it had to be dug out. It also necessitated remixing, by hand, on the sub-grade.

Many expedients were tried to overcome this unmixing, but as far as the writer knows, none have proven as satisfactory as has the admixture of a small percentage of hydrated lime. The introduction of hydrated lime seems to have prevented in many cases the separation or unmixing of the wet concrete.

Hydrated lime imparts a workability or mobility to concrete which aids materially in spreading, screeding, belting and finishing in general, whatever method is used. All of this contributes to ease of placing and consequent economy.

It is generally recognized that one of the greatest enemies to concrete is absorbed moisture. Tests have shown that the internal stresses set up by alternate wetting and drying of a mass of concrete, not to mention the freezing of the entrained water, are greater than those caused by temperature or the application of ordinary external forces. The stresses caused by moisture are also the most insidious.

Density, as applied to concrete, has been the subject of much academic discussion, theories and claims as to "Mass-volumes," "Relative Specific Gravities," "Fineness Moduli," etc., have been advanced and argued pro and con.

Hydrated Lime a Water-Tightener

Reduced to its lowest terms, and the one with which the practical engineer is most concerned, density may be rather loosely defined as that property or condition of concrete which causes it to resist the infiltration or passage of water. In other words, water tightness is a function of density, from a practical point of view as it affects the street and highway engineer.

Hydrated lime is the most efficient water-tightening medium available. The statement to the effect that it is the most efficient medium, has been made by the United States Bureau of Standards as the result of an exhaustive series of tests in which all of the available media were experimented with.

The action of hydrated lime, as a water-tightener, is purely mechanical. It is much finer in texture than any of the other ingredients of concrete so that it slips into and

fills up what would otherwise be voids of minute dimensions. Hydrated lime has the property of absorbing its own weight, or more, of water. When wet, it makes a very slippery and sticky paste. The slipperiness imparts workability to the mass and the lime paste acts as an internal lubricant. The stickiness holds the particles together and thus prevents unmixing.

The lubricating effect not only makes the handling and placing of the mass easier, but also promotes a more compact arrangement of the particles of the other ingredients, thus increasing the density.

The property of absorbing water, for which it has no use chemically, being fully satisfied, reduces the free water content of the entire mass since the water is restrained by the hydrated lime. When the excess water evaporates, it does not leave pores or cavities within the mass of the concrete, since it is present, largely, as envelopes of the particles of hydrated lime, instead as of globules or droplets.

The volume of wet hydrated lime varies but little from that of the dry, so that the desiccated hydrated lime in the mass of hardened concrete occupies practically the same space or volume as the wet paste in the mixture. Excepting at or near the surface, the hydrated lime in a mass of concrete undergoes no chemical change. That portion of it which is near enough to the surface to be acted upon by the carbon dioxide of the air does undergo a chemical change and becomes crystalline calcium carbonate, or to all intents and purposes, limestone. ($\text{CaO}, \text{H}_2\text{O} + \text{CO}_2 = \text{CaCO}_3 + \text{H}_2\text{O}$) this change is accompanied by a slight increase in volume of each particle (ratio .74—1.00) thus making a hard, insoluble surface seal. As the surface of the concrete is worn off by traffic, or otherwise, the desiccated hydrated lime, which is then exposed, starts to take up carbon dioxide from the air and forms a new surface seal. Should the moisture penetrate the surface seal in any way, the desiccated hydrated lime within the mass immediately adsorbs it and in so doing swells very slightly, thus forming an effective barrier against the passage of more water. This is the reason why hydrated lime makes concrete watertight.

In passing, it may be of interest to note that when Portland cement sets, hydrated lime is liberated, so that when we add hydrated lime to Portland cement, nothing foreign is being introduced.

As a general rule, the coarse aggregate is the strongest ingredient and the most resistant to wear, so that other things being equal, the concrete containing the largest percentage of coarse aggregate should offer the greatest resistance to wear. The aggregates are also the cheapest ingredients of the concrete.

Experiments and studies, extending over many years, by the Delaware State Highway Department, have proven conclusively that 1-2-4 concrete with 10% hydrated lime gives better service, cracks less, wears better and is cheaper than the 1-1½-3 or 1-2-3 mixes generally used. As a consequence of these tests, the 1-2-4 mixture with 10% of hydrated lime has been adopted by Delaware as well as other states and cities and its use is rapidly growing. A very significant approval of this practice is, that the Office of Public Roads will approve and extend government aid to concrete road projects in which this mixture is specified.

Numerous tests have demonstrated that the compressive strength of concrete is little affected by the presence of hydrated lime, the majority show a slight increase, when the tests have been conducted under conditions approximating field conditions. With the exception of absorption and permeability, both of which are materially decreased, none of the other properties of concrete are affected to any great degree.

The National Lime Association does not advocate the substitution of hydrated lime for Portland cement in concrete mixtures, all of the other ingredients of the mixture remain the same and the hydrated lime is added as an additional ingredient.

Summarizing the advantages of the admixture of hydrated lime in concrete:

It prevents segregation or unmixing, resulting in uniformity.

It lubricates the concrete making placing and finishing easier.

It forms a hard, insoluble watertight skin on the surface.

It promotes a more compact arrangement of the other ingredients.

It is the cheapest and most efficient watertightener.

It retains moisture which assists in the curing of the concrete. Paper read before City Paving Conference, Philadelphia, Oct. 20-21, 1921.

Appendix

An example as to how a saving may be affected by the use of 1-2-4 concrete with 10% of hydrated lime as compared with a 1-1½-3 without hydrated lime.

Let us assume a concrete road 16 ft. wide and of 6 in.-8 in.-6 in. section. Such a road will require about 1,800 cubic yards of concrete per mile.

Using the Taylor and Thompson proportioning tables and current New York prices for materials (as of Sept. 29, 1921) we find the following:

Quantities and Costs of Materials Per Mile of Road

1-1½-3 Mixture:

Cement 3,600 lbs. at \$2.50 net	\$9,000.00
Sand 756 c.y. at \$1.25	945.00
Stone 1,512 c.y. at 1.90	2,872.80

Cost of Materials Per Mile.....\$12,817.80

1-2-4 Mixture:

Cement 2,826 bbls. at \$2.50	\$7,065.00
Sand 792 c.y. at 1.25	990.00
Stone 1,584 c.y. at 1.90	3,009.60
Hydrate 53 tons \$16.00	840.00

Cost of Materials Per Mile.....\$11,904.60

Cost of 1-1½-3 mixture.....\$12,817.80

Cost of 1-2-4 mixture.....11,904.60

Saving in cost of material per mile 913.20

Equivalent to a saving of 7.12%

REPORT ON LONG BRANCH WATER WORKS

SEVERAL letters passed between the New Toronto Utilities Commission and the engineers with respect to Long Branch buying water from New Toronto in which New Toronto was prepared to sell water on a sliding scale from 15 cents to 9 cents per gallon for 100,000 gallons per day, with a minimum bill of \$225 per month. New Toronto would charge a flat rate of 10 cents per 1,000 gallons, plus 62 percent. of the carrying charges on a 16-inch main to the town limits. In a report recently submitted to the Long Branch taxpayers on the proposed water works system, the engineers, Frank Barber and Associates of Toronto, go into the question in detail.

R. O. Wynne-Roberts, a member of that concern, in his report quotes an act of 1918 whereby Etobicoke township was empowered to extend a system of waterworks to connect with any existing system owned by another corporation, and he considered it more satisfactory to pay cash for an extension of the main than to pay for it in the water supply charges. This would then remove the difficulty of the minimum monthly charge which would be a burden upon the residents in the areas not thickly populated.

The extension of a main from 6th street, New Toronto, to 22nd street, or the limits of the town would cost approximately \$40,000, and to retire 30-year seven and one half per cent. debentures on \$24,800 or 62 per cent., would cost \$510 per day should cash be paid.

New Toronto Supply Cheaper

The engineers' report shows that until the daily consumption reaches 200,000 gallons per day, the New Toronto water supply would certainly be cheaper for Long Branch. New Toronto pumping capacity for filtered water is over 9,000,000 gallons per day. At present the G.T.R. consumes about 500,000 gallons per day, whereas an independent scheme for Long Branch district would have to be built up from nothing.

Detailed Estimate of Costs

Inasmuch as 6-inch mains would doubtless be laid as local improvements, according to petitions received, the sum required for the scheme would be:

16-inch mains	\$26,900
12-inch mains	22,500
8-inch mains	10,000
Elevated tank, meter	30,000

6-inch mains	50,000
Birmingham street extension	24,800
	\$164,200
10 per cent. contingencies	16,420
Total cost	\$180,620

This sum includes about 30,000 feet of mains compared with 50,000 feet, costing about \$300,000 in the July report. To retire debentures a tax of 8.7 mills would be levied.

Mr. Wynne-Roberts in closing his report advised that a minimum pressure of 40 pounds per square inch be maintained at all times and 70 pounds for six hours at night to provide for fires.

Supplementary Report

In a supplementary report in answer to Etobicoke council regarding the possibility of obtaining a supply of water in Long Branch at a smaller initial cost, the engineer points out that as there is already a 6-inch main capable of carrying 120 gallons per minute up to 24th avenue. For about \$8,400 a pumping station could be installed on the northwest corner of the Mimico Asylum grounds to raise the pressure. For this water New Toronto would charge 10 cents per 1,000 gallons. Surplus water could be pumped into an elevated tank. The cost of the main would be \$60,600, and when a permanent source of supply had been decided upon the temporary station could be disposed of for around \$4,000.

PROFESSIONAL ENGINEERS' ASSOCIATION MEETS

WITH recommendations urging that steps be taken in co-operation with other associations interested to have public estimates prepared earlier in the year so that works can be put in hand in February of each year instead of July, and that some action be taken toward urging an increase in the number of grain elevators in Vancouver, the 1921 council of the Professional Engineers' Association of B. C. brought their year's work to a close at a meeting held in Vancouver, B.C., on Dec. 26. The appointments by the provincial government to the 1922 council were received and the government representatives will be Prof. E. G. Matheson, J. Peck, G. Wilkinson and W. R. Bonnycastle.

In addition to discussing tentative arrangements for closer co-operation and inter-professional business between the Professional Engineers, the Mining Institute of Canada and the Architects' Institute, the council also made recommendations to their successors which will result in the creation of a legislative committee and a library committee. The latter committee will take in hand and improve the technical library which is now open to all engineers at 930 Birks building; and in addition will furnish a list of technical magazines to the city library, as the authorities there have reported that such magazines are in great demand. New members enrolled included Col. J. M. Rolson, Alex. Barclay, G. W. Allan and G. K. Williams.

NEW HYDRO TRANSMISSION LINES

THE Ontario Hydro-Electric Commission is making good progress building another transmission line from the Niagara river to Toronto. It will carry power from the new plant at Queenston. When it is completed, the Hydro will have four complete circuits between Toronto and Niagara capable of carrying 200,000 horsepower. When the Electrical Development Co. plant is added as a result of the clean-up deal, the Hydro will have six complete circuits. A saving of about fifteen miles in distance and of nearly half a million dollars in the cost of the new transmission line is being affected by running it across the Burlington beach instead of through Hamilton. The towers are being placed well to the north of the Niagara escarpment. The existing towers are on the heights. They are 880 feet apart, which is a record span for swinging electric cables. When the Chippawa canal is working to maximum capacity the Hydro will require five sets of towers on five separate rights-of-way leading from the Niagara river.

The Water Commissioners of St. Catharines, Ont., reference of whose long terms of office was made in a recent issue of "The Canadian Engineer," were a few days ago re-elected once more by acclamation for another two-year term.

AMERICAN METRIC ASSOCIATION MEET IN TORONTO

THE Annual Meeting of the American Metric Association was held in Toronto on December 29, 1921.

Dr. George F. Kunz of New York presided. The members were officially welcomed by Controller Russell Nesbit of the Toronto Board of Control and W. H. Alderson, President of the Toronto Board of Trade.

W. M. Crocker, who represents the American Metric Association in Washington spoke on "The Legal Status of the Metric System and Pending Legislation." The Canadian members present were unanimous in the opinion that the passage of an effective metric bill by the United States Congress would soon be followed by similar action in the Canadian Parliament. The Association continues to present to Congress additional endorsements from National and State organizations of the Britten-Ladd metric bill now receiving the consideration of the Senate Manufacturers' Committee.

Professor Henry G. Bayer of New York University concluded the morning session by speaking on "The Evolution of Metric Weights and Measures." He cited the speech of Talleyrand in April, 1790, on a "new system" of weights and measures advocating, "that other nations should be invited to make it international." Mr. Bayer showed that even then this desire for the advantages of international weights and measures was stirring in America. He quoted as follows from the message of George Washington to Congress on October 25, 1791: "A uniformity in the weights and measures of the country is among the important measures submitted to you by the Constitution; and, if it can be devised from a standard at once invariable and universal, must be no less honorable to the public councils than conducive to the public convenience."

Theodore H. Miller, Works Manager of the De Laval Separator Co. said in part, "About 1910 we changed to the general use of the metric system throughout our plant. The advantages gained by the use of so simple a system as the metric, have been worth to us more than ten times the slight initial cost required to make the change. By placing on our drawings the expression 'All dimensions in millimeters,' we follow the practice recommended by the American Metric Association, and avoid the necessity of placing even the familiar abbreviation MM after figures."

After discussion of the best methods of using the metric system the following resolution was adopted:

"That a copy of the third edition of the booklet, Metric Weights and Measures, be sent to the leading industrial and commercial associations in Canada and the United States with the request that:

(1) This publication be examined by the proper committee or committees with a view to ascertaining whether or not the committee or committees approve of the methods outlined for teaching and using the metric system; and that,

(2) Statements or principles in this publication on which there may be differences of opinion be noted and sent with recommendations for the improvement of the fourth edition of Metric Weights and Measures to the American Metric Association."

Chairman E. C. Bingham of the Committee on Local Sections has co-operated with the American Chemical Society and other organizations in having 300 of the universities and colleges order their chemical supplies in metric units. Manufacturers and dealers have been found very willing to fill orders in this manner.

Edward Richards and other members present from the Society of American Foresters spoke on "The Application of the Metric System to Forestry."

W. W. Pearse of Toronto, well known as a construction engineer, spoke on co-operation in the metric campaign.

ROAD METHODS IN BUILDING WORK

THE time and labor saving plant and methods employed in making concrete roads are seldom applicable to ordinary building work in concrete, but can be adopted with highly satisfactory results on large contracts where extensive floor areas have to be concreted at ground level. A case in point is the laying of concrete flooring in a factory addition in Milwaukee, the total floor area amounting to more than 250,000 sq. ft. By making use of road-paving methods, it is stated that the concrete flooring was laid at the rate of over 9,000 sq. ft. in a working day of 7½ hours. Railway lines were laid outside the building for the delivery of gravel and sand and by trucks, the materials being unloaded by a grab and transferred to a large hopper bin with

separate compartments. Gravel and sand were conveyed from the bin to the concrete mixer by means of side-discharge cars running on a narrow-gauge track. Cement—the only material not handled by machinery—was wheeled to the mixer in barrows. Mechanically-operated trucks were used in delivering mixed concrete, which was discharged direct into the trucks, and therein transported to the required points and rapidly tipped out by the front-tilting body. About 114 trips were made by each truck per day of 7½ hours, or one complete trip ever four minutes. The whole operation of mixing, discharging, and transporting the mixed concrete was planned so as to avoid the slightest loss of time at any point.

IMPORTANT ORDER FOR DOMINION ENGINEERING WORKS

THE Water Works Department of the City of Montreal has recently placed an order with the Dominion Engineering Works Co., Ltd., of that city, for extensive additions to the city pumping equipment and distribution system. The contract includes three 30-million gallon, electrically driven, centrifugal pumps, to operate against a head of approximately 250 feet; 12 36-in. Johnson hydraulic valves, of a combined stop and check valve type; 6 42-in. suction gate valves.

The Johnson hydraulic valves are of special design, and close automatically in case of breakage and drop of pressure in the main on the pump side of the valve, preventing the escape of large volumes of water and consequent damage to property.

The feature which makes these valves peculiarly suitable for water works service is the closing movement, which is rapid at first, then slows up during the last part of the stroke, effecting a complete closing, promptly, yet without water hammer or injurious stress on the piping system. The valves may also be closed at will by the operation of certain simple means for the purpose.

The manufacture of large special gate valves has lately been taken up by the Dominion Engineering Works, as their mechanical equipment enables them to handle such work in the largest sizes yet produced. This is evidenced by the fact that they are now building the largest Johnson hydraulic valve ever made, some 20 feet in diameter, for installation at Shawinigan Falls, Que., under a head of 140 feet. Estimated weight of this valve is 365,000 lbs.

HYDRO INDEBTED TO SCIENTISTS

IN addressing the general session of the American Association for the Advancement of Science in Convocation Hall, on Dec. 29, Sir Adam Beck, chairman of the Ontario Hydro-Electric Power Commission, paid full measure of tribute to the part that science has played in the creation of the largest electric power system in the world.

Not a little of the success of the Chippawa development, stated Sir Adam, was due to the intensive work carried on in the laboratories of the Commission. Problems which appeared insurmountable had been overcome by the intensive application of the most exhaustive research methods. Sir Adam cited the success of the Commission in discovering a cheaper and better concrete mixture as one case in point. Another instance was the invention of an insulator for high voltage transmission lines which had been adopted by almost every country in the world.

As illustrative of the advantage which Ontario enjoyed in possessing cheaper electrical power than could be generated by steam plants, the speaker told the visiting scientists of the difference in power prices between Windsor and Detroit. After being transmitted 254 miles, power had been sold to the consumer in Windsor for four and one-half cents per kilowatt-hour. In Detroit, power generated by one of the most efficient steam plants in existence was being sold at eight cents. Further than that, the surplus earned on the distribution of power to Windsor had been eighty thousand dollars in one year, with the result that six months ago the cost of power in that city had been lowered to three and one-half cents per kilowatt-hour.

Public ownership and development of Ontario's water falls had brought power to the small consumer, to the average householder, and to the smallest communities. A village such as Glencoe, which only used ten horsepower, had shown an annual surplus of \$854. In the City of Toronto the average monthly bill of 60,000 consumers was only 89 cents per month.

PROGRAM AMERICAN GOOD ROADS CONGRESS

THE following tentative program of papers has been arranged for the sessions of the twelfth American Good Roads Congress which will be held at the Coliseum, Chicago, on Jan. 16 to 20 inclusive.

Bituminous Roads

Bituminous Foundations, by Hugh W. Skidmore, C.E.
Selection of Bituminous Bearing Course, by C. M. Pinckney.

Utilization of Local Material for Mineral Aggregate, by Major W. A. Welch.

Asphalt Specifications, by L. M. Law.
Specifications of Mineral Aggregates, by Roy M. Green.
Controversial Construction Requirements in Specifications, by Bruce Aldrich.

A Simple Graphic Method of Proportioning Sands for Sheet Asphalt Mixtures, by Prevost Hubbard.

Portland Cement Concrete Roads

The Selection of the Mineral Aggregate for a Portland Cement Concrete Roads by John H. Mullen.

Design of Concrete Roads for Heavy Traffic, by W. D. Uhler.

Inspection and Control of Materials for Concrete Roads, by R. W. Crum.

Importance of Surface Finish and Methods of Control, by H. E. Breed.

Single Track Concrete Roads for the Average County, by P. C. McARDLE.

Pavement Widths for Highway Serving Large Cities, by Edward N. Hines.

Common Roads

Common Roads, by T. J. Wasser.
A Systematic Study of Gravels for Road Purposes, by Wallace F. Purrington.

Highway Financing

The Proposed Wisconsin Plan of Highway Finance, by A. R. Hirst.

The Minnesota Experience in Highway Financing, by C. M. Babcock.

Highway Traffic and Transportation

Truck Overloading, Its Relation to Road Construction and Maintenance, by J. G. McKay, Ph.D.

Highway Research

Highway Research, by W. K. Hatt.
The Illinois Experimental Road, by Clifford Older.
Highway Researches and what the Results Indicate, by A. T. Goldbeck.

The Highway Outlook, by Thomas H. MacDonald.
Cost Keeping on Highway Construction, by A. R. Losh.
Development of Small Stream Valleys into Traffic Routes, by Jay Downer.

Uniform Legislation as Affecting Highway Traffic and Highway Transport, by D. C. Fenner.

Construction and Maintenance of Earth Roads, by George E. Johnson.

Highway Construction on the Pacific Coast, by Herbert Munn.

Co-operation of All Parties Interested in the Construction of a Modern Road, by William Ord.

The Business End of a State Highway Department, by Charles M. Upham.

The Highway Contractor's Problems, by H. H. Wilson.

ENGINEERING STANDARDS

SEVERAL new specifications have recently been issued by the British Engineering Standards Association, all at the standard price of 1s. each, or 1s. 2d. post free.

A report on standard channels and beams for structural purposes includes details of the geometrical properties, such as the moment of inertia and the modulus of section (moment of resistance). Tables are also added showing the approximate metric equivalents of the British measurements, though it is indicated that the figures in British units are to be regarded as the standard. A specification for tramway axles follows closely the lines of the revised specification for railway carriage and wagon axles, 0.5 per cent. of phosphorus or sulphur being permitted in the steel, though no particular process of making steel is required to be adopted.

Among electrical specifications one deals with metallic resistance materials, which are divided into five classes ac-

cording to the purposes for which they are required. It has not been found possible to specify definitely a value for the resistivity of any type of material on account of the large number of different makes, but it is required that the value shall not differ from the value declared by the makers by more than 5 per cent. A step towards the simplification of switch-gear is marked by the issue of a specification for air-brake knife switches and laminated brush switches and of another for air-brake circuit breakers, in both cases for pressures not exceeding 660 volts. During the preparation of these two reports it was realized that before many of the conditions could be laid down with any certainty a large amount of research work must be done, particularly in regard to rupturing capacity for large sizes and safety of insulation. A comprehensive research is therefore being undertaken by the Electrical Research Association, and it may be possible to extend the specifications when the results become available.

Finally, there is a specification defining the physical and chemical properties required in creosote that is to be used for the preservative treatment of railway sleepers and telegraph and telephone poles.

ENGINEERS REQUIRE BUSINESS TRAINING

COMMISSIONER of Works, R. C. Harris of Toronto, has found after 36 years' experience with engineers, that their university training has been lacking in some important essentials. Mr. Harris stated this year very plainly recently in an address before the American Association for the Advancement of Science.

"An engineer should be essentially a business man, but frequently he is not," said Mr. Harris. "He seems to have been given training exclusively along engineering lines, and often has little ability for studying himself or others."

Mr. Harris said he had found engineers did not have a proper sense of the economic value of their own creations. They delighted in doing things, but could not determine as to the practicability of many of their efforts.

Another point in which he had noticed a lack in the equipment given to the engineer at the university was the faculty for mixing with his fellow men and getting the viewpoints of others. He lies too much in a world to himself, the speaker thought.

A strong criticism was made of the frequent financial hardships worked to business men and public corporations because of erroneous estimates of engineers. Sometimes, the speaker pointed out, works cost three and four times the engineer's estimate, and he considered this a discredit to the profession. A suggestion was made that instructors should be enabled to travel widely and come in first-hand contact with the latest doings in other places.

Brig.-Gen. Mitchell, dean of the faculty of applied science of the University of Toronto, said he agreed with all the criticisms made by Mr. Harris. He held that the faculty should expand its course of training, but he thought under any circumstances it would be found difficult to give a young man all the fundamentals of applied science in four years.

UNEXPECTED TEST OF AN ARCH

A REINFORCED concrete arch of 86-ft. span, forming part of a highway bridge constructed last year at Herkimer, New York, was subjected to an unexpected and severe test when the work of concreting had been completed only 12 hours. Owing to heavy rains during the deposition of the concrete the water in the river spanned by the bridge rose about 5 ft., washing out or undermining the supports of the centring, and carrying away part of the latter to such an extent as to leave the arch entirely without support, save that afforded by the moulds in which the concrete had been deposited. Notwithstanding the sudden strain so imposed on the concrete no injury of any kind was caused in any part of the arch.

The bridge comprises three arches in the river portion, each with a span of 86 ft., a rise of 20 ft., 6 in., and including two ribs 5 ft. deep at the springings and 1 ft. 9 in. at the crown. The ribs are reinforced with $\frac{7}{8}$ -in. longitudinal bars at the intrados and extrados, with transverse and radial rods connecting the main reinforcement. The concrete was mixed in the proportions of 1:2:4, the aggregate consisting of broken limestone. Although the concrete in the first rib moulded was 60 hours old when the centring dropped, the resistance of the arch as a whole is none the less remarkable.

ACTION OF OILS UPON CONCRETE

A CIRCULAR addressed to members by the German Concrete Association recapitulates the various results of tests and experience relative to the storage of oils in concrete tanks. While concrete is unaffected by most mineral oils, those of vegetable and animal origin are apt to be injurious owing to the presence of acids. It is however, considered desirable to line the interior of all oil storage tanks with some impervious material, capable of preventing the oil even if of harmless character, from penetrating the concrete.

The following essentials are stated in the circular mentioned: (1) The lining should be effective in resisting penetration by the oil and the attack of fatty acids; (2) the lining should be able to protect the structure if the latter were afterwards used for water; (3) it should be possible to heat the oil up to the boiling point without injuring the lining; and (4) the satisfactory condition of the tank should be assured not only by means of the lining but also by proper design and construction. Asphalt or kindred linings are not recommended, as they are soluble in oil, a more reliable method being to impregnate the skin of the concrete with a solution of mineral salt, such as silicate of sodium, capable of combining with the alkaline constituents of the cement so as to form insoluble products constituting an impenetrable screen. According to tests conducted at Lichterfelde, a lining proposed by Professor Marcassin has been found perfectly unaffected by an animal, vegetable, and mineral oils. The lining in question consists essentially of margarine, an artificial resin resulting from the condensation of formaldehyde with phenol. It can be employed in the form of an oil paint, which dries so quickly that it may be put in service at the end of a day, and can be applied either to interior rendering or to the surface of the concrete as it is left on removal of the shuttering.

CONTROL PROVIDED FOR LAKE OF WOODS

REGULATIONS providing for the control of the waters of the Lake of the Woods and their maintenance at certain levels, have been approved by the Governor-in-Council. They provide that all dams, structures and other works, which have been, or may be constructed on any outlet of the Lake of the Woods, or on the Winnipeg River at or above its junction with the English River, shall be constructed, maintained, operated and repaired in such a manner as to secure at all times the most dependable flow and the most advantageous use of the waters of the Winnipeg River. They must also regulate and control the outflow of the waters of the lake so as to maintain its level between elevations recommended by the report of the International Joint Commission of June 12, 1917, or between such elevations as may be agreed upon by the United States and Canada, and so that obligations of the Dominion or any of the Province toward the United States in this regard may be carried out.

The Lake of the Woods Control Board must determine the levels and flows necessary to be maintained from day to day or for any period of time in conformity with the regulations. The Board is empowered to "issue to those persons or authorities directing, controlling or maintaining any of the aforementioned dams structures or other works, orders with respect to the levels and flow determined by the Board as well as the manner and method by which they may be maintained."

PRECEDENT FOR HONORING ENGINEERS

RECENTLY, the city council of Minneapolis, Minn., performed an unusual and gracious act in its decision to name the great Franklin Avenue reinforced concrete bridge, which contains a 400-ft. arch span, the longest in the world, the Cappelen Memorial Bridge in honor of the late F. W. Cappelen, who for over twenty years was the city engineer of Minneapolis. It is only too common experience to find small calibre politicians accorded recognition and honor for imaginary services, while the hard working, conscientious and able engineer is wholly ignored. Minneapolis has not only done a signal honor to the engineering profession in according this recognition of the great services of its able city engineer, but has done itself honor in establishing a precedent which it is hoped may be followed by other municipalities under like conditions.

LETTER TO THE EDITOR

WOOTEN-BOWDEN SCHEME VERSUS HYDRO PROPOSALS FOR ST. LAWRENCE DEVELOPMENT

Sir—As you have just completed the publication of the Wooten-Bowden report on the proposed improvement of the St. Lawrence, as well as synopsis of those of the Hydro Electric Power Commission of Ontario, and of Hugh L. Cooper, of New York, and as you have expressed the opinion editorially on October 6th and November 24th, that the position of the Hydro Electric Power Commission in Ontario lends special importance to their representations, I presume you will give me a little space, so that I may help to clear up some things that appear to be misrepresented.

The Hydro report, as submitted to the International Joint Commission, does not give quantities, unit prices, or sections of structures, such as are given in the Wooten-Bowden report for the scheme they recommend, so that a close comparison cannot be made of the Hydro schemes with that of Col. Wooten and Mr. Bowden.

An examination of things that can be compared shows the Hydro estimates of cost for locks, excavation, and lands to be grossly inaccurate and misleading. The amount of power that can be obtained, under their favored scheme "B," is greatly overstated, or stated in such a manner, that the reader would think that the power output from the carrying out of such a scheme would greatly exceed what can be secured by the Wooten-Bowden project. This scheme "B" is practically the same as that presented by the New York and Ontario Power Co. of Waddington, N.Y., and varies only slightly for the works at the Long Sault Rapids, from that put forward by the Aluminum Co. in 1907.

Your editorial of November 24 states that this proposal is, in some respects, superior to the Wooten-Bowden project, but I am sure you have arrived at your conclusion from a very incomplete examination of the merits of each, and before you had read the rebuttals of Col. Wooten and Mr. Bowden. This scheme contemplates no special arrangements or improvements to eliminate the annual ice jams at Cornwall and the Long Sault Rapids, which occur at the present time. It proposes to maintain open water in winter in all the reaches from Cornwall to Galop Rapids and calls for the completion of a power development at Waddington, N.Y., before the development at the foot of Barnhart Island, near the Long Sault Rapids, is made.

Before going on to explain the situation, as the writer has found it, some of the fallacies of this scheme must be pointed out. As Col. Wooten and Mr. Bowden have stated the power obtainable by their project on a very conservative basis, and as the Hydro has stated the power obtainable in their scheme "B" on a very liberal basis, it may be better, in this letter, to state the advantages of each in feet of head, rather than in power.

The head to be obtained in the Wooten-Bowden project, for mean discharge, will be (231.8-156.8) or 75 ft. For low river discharges, it will be (230.5-155.3) or 75.2 ft. At peak load hours, during which time 230,000 c.f.s. may be used at Barnhart Island, the head under the Wooten-Bowden project would be reduced, by a temporary lowering of the upper level, of 0.8 ft., and the raising of the lower tailwater level by 0.6 ft., which reduces the net head to 73.6 ft. The output at peak loads at this head would be 1,750,000 h.p., including the 56,000 h.p. developed at the head of the Massena Canal. In winter the head will be reduced by the effect of an ice cover on Lake St. Francis but as the open water from the Long Sault to Cardinal will be done away with the backwater from the present winter jams, which often reach 25 ft., will practically disappear. By a comparison with similar situations elsewhere, a rise of four feet is predicted in the tailwater level in severe winter at the Barnhart Island plants, due to this ice cover, and this reduction in head in the Wooten-Bowden project will have an ordinary operating head of 71 ft. in winter, and 69.6 ft. while carrying the above described peak loads.

Under summer conditions, the Hydro's scheme "B" must be compared with the above, using the same water levels at the foot of Barnhart Island, as the works proposed below are the same. In their plans, they show a water surface elevation of 241.8 above their Ogden Island dam and a surface slope of 4.65 ft. between the plant at

Ogden Island and Barnhart Island. This gives a gross head development of $(241.8 - 156.8) - 4.65 = 80.35$ ft. This gross head has to be reduced when carrying peak loads, by a loss of 3.8 ft. in the headrace at Ogden Island, where there will be a velocity of nearly 7.0 ft. per second, as well as an injurious surge. It will have to be reduced by 2.0 ft. on account of a surge at Barnhart Island, and 1.5 ft. on account of lower efficiency and loss of kinetic energy due to the double development, so that the net effective head, even in summer, is only 73.0 ft., or slightly less than that in the Wooten-Bowden project.

In winter, however, the situation is quite different, and the Wooten-Bowden project is found to give enormously more power than the Hydro scheme "B." An average additional loss due to the ice jams at Cornwall and above, of at least 15 ft., must be expected, and it will at times be as much as 25 ft. The proposals of the Hydro are to maintain open water from the power plants at Barnhart Island to the plant at Waddington, and from the plant at Waddington to above Galop Rapids by means of ice breaking tugs, if necessary. They thus propose to leave the conditions which have caused the ice jams above Cornwall, still operative, and as these jams have caused an average rise of 18 ft. in seven out of ten of the winters of which we have record, and a maximum rise of 25 ft. in February, 1918, the loss of head is truly appalling, and the net head of 73.0 ft. will be reduced to not more than 58 ft., and may be reduced to 48 ft.

This reduction would not be serious at the plant at Waddington, N.Y., but would be very serious at the plant at Barnhart Island, as all the reduction would fall on it. Fifteen feet head, with the maximum flow permissible, viz. 230,000 c.f.s., amounts to 345,000 h.p., and this fairly represents the output by which the Wooten-Bowden project exceeds that of the Hydro in scheme "B." Further, on account of the large headrace channels leading to the power houses at the foot of Barnhart Island, and the great pondage area provided above Dickinsons Landing, the Wooten-Bowden project, if built, could utilize 230,000 c.f.s. at the Barnhart Island plants, for a period of six hours, and deliver 1,750,000 h.p., while the other power plants as shown in the Hydro scheme "B" have so little pondage to draw from, and such small headrace channels, that the gain from the extra quantity of water utilized will be nullified by reductions in head at the plants, and the actual output at no time would equal the above 1,750,000 h.p. of the Wooten-Bowden project.

The writer is only a special pleader for a single development scheme, as against a double development scheme, when it is assumed either that it is right and proper that a part of Canada's share of the St. Lawrence power be exported to the United States, or that a market for all of it will be developed in Canada before the end of half a century. If, however, it be decided that neither of the above can be accepted, then a double development scheme becomes a close competitor of the Wooten-Bowden project, but not one having any similarity to the Hydro proposals "B" or "C."

The double development scheme, which I have in mind, would place a 62-ft. plant at the foot of Barnhart Island, and equip it immediately, and it would leave a 12 to 19-ft. plant undeveloped at Waddington until needed. Such a project would not injure Morrisburg, Aultsville or Farrans Point, but it would have the effect of placing the development at Waddington in a very unfavorable position. The present value of the Waddington site under such a program would be almost nil, on account of delayed development, and on account of the fact that when put into commission, difficulty would be found in operating the units of such a plant at constant speed. On account of the variation in head that would occur at this plant, it is held by some engineers that its power could not be used except for special purposes. I personally regret that the Hydro did not devote their energies to a study of this project, instead of those they presented.

In the report of Col. Wooten and Mr. Bowden, all reasonable alternative schemes in the all Canadian section of the St. Lawrence were described, and estimates were given of the cost of all these, but in the International section, alternatives were left out for sympathetic reasons. Three schemes might have been submitted, from which it would have been difficult for a non technical commission to choose. However, it is not difficult to choose between that of the Hydro Electric Power Commission and the project submitted by Col. Wooten and Mr. Bowden.

The Hydro, in their report, adhere to the view that Canada should permit the exportation of part of her share

of the power on the St. Lawrence. By this action, they support the project chosen by Col. Wooten and Mr. Bowden, on the only ground on which it is open to attack. It also makes a prophecy regarding the growth of a market, which, when applied, greatly favours the single stage method of development.

167 Carling Ave., Ottawa, Ont. D. W. McLACHLAN.

[Our editorial comment of Nov. 24 could scarcely be interpreted as advocacy of any particular scheme of development for the St. Lawrence Waterway. On the basis of newspaper reports of the Hydro-Electric proposals, which were the only reports available at the time of writing the editorial, it was stated that "it appears that scheme B prepared by the Hydro-Electric Power Commission is in some respects superior (to the Wooten-Bowden one)". No editorial comment on this matter was made in our issue of Oct. 6—EDITOR.]

QUEENSTON HYDRO PLANT OFFICIALLY OPENED

Nearly five years of skilled engineering effort, night and day labor, and overwhelming financial anxiety were crowned with success on Dec. 28 when power was officially turned on at the new Queenston power plant. Sir Adam Beck, on whose shoulders the tremendous weight of responsibility has rested during the entire period, presided at the ceremonies, and received ovations from over 2,000 municipal representatives such as few Canadian public men have been accorded.

When Premier Drury and Miss Marion Beck released the flood of water into the first installed turbine it set in motion the 55,000-horsepower generator. As the machine increased its speed, the first of Chippawa's power gradually brought into brilliant illumination a large sign on the wall of the power house: "Queenston-Chippawa Development, the largest Hydro-electric plant in the world. Ultimate capacity 650,000 horsepower."

From a faint glow of light to a white glare the electric sign gradually mounted as the generator picked up to its normal speed of 187 r.p.m. The whole of the official ceremonies occupied less than fifteen minutes.

Outstanding in Sir Adam's utterance at the after-luncheon address was his summarization of what the excess of estimated cost actually meant to Ontario power users. It meant just one-sixth of one per cent per kilowatt hour for power users, who were now paying two cents for Hydro, as against four and five times that price under private ownership.

"I ask you," he interrogated, "is that going to make it impossible for you to meet your obligations to the Government? Can you expect to default in any respect, shape or form because of the increased cost? No one regrets the \$30,000,000 expenditure in excess of the first estimates more than I. No human being could have foreseen that \$30,000,000."

Sir Adam enumerated all the plant additions and improvements which the \$30,000,000 excess of estimated cost had brought to the Province. It had meant a tripling in power productiveness, and out of it a duplicate canal had been provided for, vast improvement in projected power house structure, and certain moneys mounting into the millions appropriated for the commendable purpose of restoring the Chippawa fort. No one, he said, could compare the original scheme at the initial estimate of cost with the present project, involving \$30,000,000 additional expenditure.

WANT ENGINEERING PROFESSION PROTECTED

THE London branch of the Engineering Institute of Canada is taking steps to petition the Ontario Legislature to make the engineering profession a closed one, and, together with other branch institutes, will present petitions to the Government at an early date praying that legislation to that end be spread on the Ontario statutes.

A closed engineering profession means that no one would be allowed to do engineering work unless he was a member of the Engineering Institute of Canada, and membership in that body is made contingent upon the application for admission holding a degree from a qualified school of science.

The local branch of the Institute, of which H. A. Brazier is interim chairman, will hold its annual meeting the third Wednesday in January, at which time officers for the coming year will be elected. The meeting will probably be addressed by J. M. R. Fairbairn, of Montreal, president of the Engineering Institute of Canada.

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GUARDING AGAINST FATIGUE IN METALS

FOR many years following the notable investigations of Wohler on the fatigue of metals, it was common practice amongst bridge engineers to fix working stresses so as to guard against the possible breakdown of the metal by fatigue. Care was taken to base the adopted unit on the relation of maximum to minimum stress, however tedious the calculations might be. In recent years, however, little regard has been paid to this relationship, it being always provided that the stresses realized would not under any circumstances exceed the elastic limit.

portance created during recent years. As a result of this and similar problems, the National Research Council of the United States organized an investigation of the fatigue of metals supported by the Engineering Foundation and the General Electric Co. The work was carried out at the Engineering Experiment Station of the University of Illinois by Prof. H. F. Moore and Prof. J. B. Koppers, and the results were published in a recent bulletin of the Engineering Experiment Station.

As a result of the extensive experiments conducted, it has been established that there is a well defined endurance limit below which metals can withstand one hundred millions or more reversals of stress without evidence of damage. With the increase of the stress above such limit, the number of reversals required to produce breakdown gradually decreases. This observation is in accord with the earlier investigations already cited. In the field of ferrous metals there appears to be no simple relation between the endurance limit and the elastic limit, the ultimate tensile strength affording a better index of the endurance limit under reversed stress than does the elastic limit. The Brinell hardness test furnishes a still better index of the endurance limit, although the reason for this is not clear.

A special incentive to the study of metals under repeated stress was given in the design of aeroplane parts during the late war. Behavior of the material of welded ships under repeated stresses was another problem of importance. It was hoped by the investigators that accelerated or short time tests of metals under repeated stress using high stresses and consequent small numbers of repetitions to cause failure would give a reliable indication of the ability of metal to withstand millions of repetitions of low stress. Unfortunately, this hope was not followed by favorable results. It did develop, however, that for ferrous metals the endurance limit could be predicted with a fair degree of accuracy by the measurement of rise of temperature under reversed stress applied for a few minutes. It is believed that this test can be developed into a reliable commercial test of ferrous metals under repeated stress and possibly to non-ferrous metals, although its applicability to such has not been investigated. In none of the ferrous metals tested did the endurance limit under completely reversed stress fall below 36% of the ultimate tensile strength. For only one metal did it fall below 40%, while for several metals it was more than 50%.

In the latter quantitative observations there is found support for the commonly accepted working stresses used in structural practice. More frequently than not, the working stress adopted is below 50% of the elastic limit for all probable combinations of loading and for structures where stresses are permitted in excess of this fraction, the number of occasions on which the stress would be realized would be so small as not to cause any danger of failure through fatigue. The results of the investigation conducted by Professors Moore and Koppers will no doubt be received with a great deal of interest and careful consideration by all engineers having to do with structural materials.

GETTING THE MOST OUT OF A RAILROAD

REMARKABLE developments in the efficiency of operation of the Ford railroad, the Detroit, Toledo and Ironton, has directed the attention of railroad engineers to what has been done in that time. Brushing aside the sentimental and palpably absurd statement attributed to Henry Ford that in order to make the railroad pay he would reorganize them "in such a way as to get rid of the unproductive stockholder." It is seen that there is apparently some sound reason for the astounding improvement in operating efficiency on the Ford road. It is stated, for example, that with 40% less force a tremendously greater tonnage is being hauled over the line than was previously the case. By speeding up the movement of freight on the preliminary part of its journey, it has been possible to expedite delivery by from 7 to 14 days. According to Mr. Ford, a considerable physical handicap on railroad operation is created through engines and cars four and five times as heavy as they should be. On the Detroit, Toledo & Ironton old and light types of engines and cars being used, later to be displaced by improved types of lesser weight than commonly employed on the railroads of this continent.

In a recent interview, Sir Henry Thornton, director of British army transport in Britain and France during the war, stated in Toronto that the railroads on this continent have gone to an extreme in making up heavy trains with 70 to 100 large freight cars requiring enormous locomotives and bridges of prodigious strength. The capital outlay thus imposed, said Sir Henry, has been staggering. Sidings of great length, very large stations, heavy rails and costly facilities all over the line have become necessary. According to his view, the result of this condition has been that the whole railway system is only suitable for very long freight and passenger traffic. Local passenger and short haul freight traffic are therefore not attractive to our steam railways and a commutation suburban service is frowned upon as unprofitable.

Such statements of opinion are calculated to bring about a reconsideration of the proper basis for successful railway operation. In these days when Canada has a stupendous railway problem upon its hands, nothing that promises relief and improvement should be overlooked.

PERSONALS

T. L. S. LANDERS, Edmunston, N.B., has been elected an associate member of the American Society of Civil Engineers.

C. McNAUGHTON STEEVES of Edmunston, N. B. has been transferred from associate membership to membership in the American Society of Civil Engineers.

PROF. J. A. McLELLAN was chosen chairman and U. P. Dobson, of the Ontario Hydro-Electric Commission, secretary, of the Committee named to arrange for the discussion of the Toronto section of the American Metric Association.

BRIGADIER-GENERAL H. N. RUTTAN, formerly city engineer of Winnipeg, was a few days ago made a Companion of the Order of St. Michael and St. George at an investiture held at Government House, Winnipeg.

CAPT. W. J. STITT, formerly of the marine staff of the Toronto Harbor Commission, and latterly with Roger Miller & Sons, Ltd., contractors, Toronto, has been appointed as Canadian representative of the Dake Engine Co., Grand Haven, Mich., manufacturers of marine engines, contractors' hoists and swinging engines, cranes, blowers, centrifugal pumps, sand dredging pumps, boilers, etc. Capt. Stitt has opened an office at 45 Adelaide St. E., Toronto, where he will be available in connection with repairs and service work for Canadian installations. He has been representing the Dake Engine Co. for the past twenty years during the winter months in Toronto for the past seven years but each summer he has returned to marine work. Arrangements have now been made, however, whereby Capt. Stitt will devote his entire time to the interests of the Dake Engine Co.

HORACE L. SEYMOUR, C.E. (Tor.) A.M.E.I.C., town planning engineer, of the firm of Frank Barber and Associates, Ltd., Consulting Engineers, Toronto, has been retained as city planning consultant to the City of Niagara Falls.

The first work will be that of consulting with the city engineer, Mr. J. C. Gardner, B.A. Sc., A.M.E.I.C., in the preparation of study maps and data. This information will form the basis of zoning maps and proposed zoning ordinances, as well as for other features of a city planning scheme. In Ontario cities but little has been accomplished in comprehensive city planning. Some Canadian cities have taken advantage in the past of the assistance furnished by the Commission of Conservation with Mr. Thomas Adams as town planning adviser. The time has come when each city must plan for itself and the City of Niagara Falls is one of the few in Ontario who are taking their zoning and city planning problems seriously. The advantages of city planning are evident and it is hoped that more Canadian municipalities will follow the excellent example furnished them by the City of Niagara Falls.



RECENT PUBLICATIONS

STEAM CONDENSING PLANTS is the title of a paper read by Paul A. Baneel before the Baltimore section of the A.S.M.E., which has been reprinted and issued in bulletin form by the Canadian Ingersoll-Rand Co., Sherbrooke, Que. In this interesting paper the author outlines the principal

fixed and operating charges in surface condenser plants and then proceeds to describe a new type of condenser developed by this company. This condenser is characterized by a special shell and cooler design combined with an arrangement of tubes in stages which results in the practical elimination of waste tubes and a condenser of greatly reduced surface. The bulletin contains a considerable amount of technical information covering the operation of surface condensers with special reference to corrosion, temperatures, cause and effect of foreign matter in tubes, etc. In the concluding pages, the merits of barometric and jet condensers are dealt with in a comprehensive manner. Copies of the bulletin may be obtained from the head office or from any of the branch offices of the company.

MASONRY REPAIRS—Bulletin 134, issued November, 1921, by the Cement-Gun Co., Inc., Allentown, Pa.; 6 by 9 in., 24 pages, 40 illustrations. The "Cement-Gun" has proven itself a machine of very great usefulness in a wide field of engineering endeavor, but in none has it met with more success or extended use than in the repair and rebuilding of masonry brick and concrete structures. Bulletin 134 illustrates a number of cases which may serve as a guide for similar use of the "Cement-Gun" elsewhere. Illustrations and information are presented regarding repairs to stone masonry at Governor's Island New York, to an arch bridge near Lancaster, to brick buildings and bridge piers, railroad tunnels, brick sewers, concrete dams, bridge piers, sea-walls, reservoirs and other structures.

THE CANADA YEAR BOOK 1920, published by the Dominion Bureau of Statistics, Ottawa. The Year Book contains as formerly a great deal of interesting information covering agriculture, trade and commerce, minerals, manufactures, etc., of Canada. All sections contain the latest information available and the tables include, where possible, the figures of 1920. The leading article this year is on the subject of "Reconstruction," while other additional subjects dealt with are: an increase in agricultural statistics, more especially in the analysis of agricultural prices; the compilation of statistics of Canadian trade according to the improved classification of commodities over a period of four years; an analysis of the statistics of passenger and freight railway services and receipts; and a valuable summary of the financial statistics of cities of 10,000 and over. Another interesting feature noted is the reorganization and expansion of two sections namely, the Climate and Meteorology section and the Labor and Prices section. Copies may be secured on application to the King's Printer, Ottawa.

INTEREST SHOWN IN TOWN PLANNING

DURING the past few years the necessity for a regular system of town planning has become the centre of much interest and study, particularly by public-spirited bodies anxious to promote civic development. One of these societies in Toronto, the Down-town Association, plans to obtain, some time in the near future, a City Planning Commission for Toronto. In view of this, the association has shown considerable interest in the cities and town planning course at the University of Toronto from January 9 to January 21, and a prospectus of the course has been sent to each of its members.

Everything connected with city or town improvement will come up in the course of the lectures and discussions. Expert opinion will be available on actual problems brought up by those attending the course. Difficulties will be discussed to find the best solution, and everything will be done to make the course practical and useful to municipal officials and others who wish to study the subject.

The four divisions of the course consist of economics, sociology, administration and technical town planning. Any of these sections may be taken without the others and single lectures may be attended for a small fee. Already two applications from Alberta have been received at the University Extension office.

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Construction Scarboro Twp. Waterworks System

First Township in Ontario to Own and Operate Its Own Water Works System — Officially Opened on Dec. 1, 1921 — Description of Plumbing and Filtration Plant, and Reservoir

BY W. D. PROCTOR, B.A. SC.,

Resident Engineer, James Proctor & Redfern, Ltd.,
Consulting Engineers

WHILE the official opening of Scarboro's new Waterworks system by Reeve J. T. Stewart of Scarboro Township took place on Thursday, December 1, residents of Water Area No. 1 have been using the new supply since Thanksgiving Day, November 7. The entire system consisting of 19 miles of mains is now in full operation. A description of the general layout of the plant and the process of filtration has already appeared in "The Canadian Engineer" under date of May 26, 1921. This plan was followed in construction throughout and only a few changes not affecting the general layout were found necessary. In this article the writer will endeavor to give a description of the methods of construction used.

Work Included in First Contract

The first contract let in April to the Central Foundation Co. included the construction of the intake, low lift pump house, pipe lines up the gully and catch basin at the top of the gully, 180 ft. above the lake. The low lift pump house was the first structure on which work was commenced. For this it was necessary to cut into the side of the bank. Excavation was done by hand and was carried 10 ft. below lake level for the suction well floor. The excavated material was dumped in front to form a sea wall and the concrete anchor blocks for the intake were also cast in front to give additional protection against storms. The excavated material was blue clay and a remarkable fact was the manner in which the walls of clay 12 to 30 ft. high stood up without shoring of any kind. Outside forms for the concrete were not used up to main floor level. No trouble was



FILTER PLANT AND HIGH LEVEL PUMP HOUSE.

experienced from water although the south wall excavation was on the original shore line and nothing more than a small diaphragm pump was ever found necessary.

The low lift station is built entirely of concrete heavily reinforced in the walls, floors and roof. The concrete was mixed on the plateau 185 ft. above the lake and was passed through wooden troughs to the forms below. The trough was divided into three sections by inserting two hoppers to check the speed of flow and to save the mix from being disintegrated. The first section was 176 ft. long and sloped 29 degrees from the horizontal. The second was 184 ft. long and sloped 27 degrees to the horizontal. The third section was short and the chutes were adjusted to suit the section poured, the longest one used being 52 ft. The trough was made of material 2 in. x 10 in. with open top. A mix of one cement to four of pit run gravel was used throughout. The system of "chuting" the concrete was found to work satisfactorily, the hoppers serving to retard the flow and prevent the mix from being broken up. Allen Brothers of Birchcliffe supplied the gravel used.

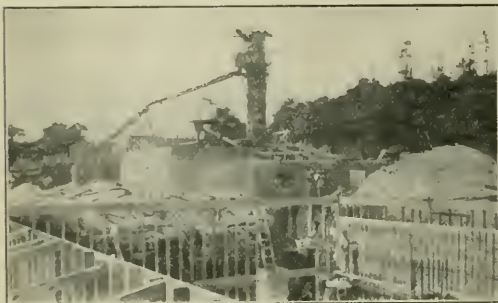
Steel Intake Pipe

The intake consists of 24 in. steel pipe in 30-ft. lengths with flanged joints bolted together by 20 $\frac{3}{4}$ -in.-diameter bolts and nuts. Basswood gaskets were used throughout. At the shore end of the intake, a 10-ft. length of pipe was cast into the sea wall. When the wall had set sufficiently, excavation was begun outside the sea wall by a dredge which had dug a channel for itself in from the lake. Pipes were laid from the shore end out in an excavated trench till water 20 feet in depth was reached at a distance of 1800 ft. from shore. From this point on, the pipe



LOW LEVEL PUMP HOUSE

was laid on the bottom of the lake to a point 2560 ft. from the shore. The water at this point is 27 ft. deep at mean water level. A 24 in. x 36 in. increasing elbow is built into a protecting crib at the outer extremity. This crib has two outer compartments filled with one man stones and an inner compartment which is covered over on top and which protects the intake inlet. The crib is built of 6 in. x 6 in.



POURING WALLS OF COAGULATION BASIN. FORMS FOR RESERVOIRS IN FOREGROUND. FILTER PLANT IN CENTER.

and 8 in. x 8 in. timbers bolted together with a clear opening between timbers of 3 in., through which the water is drawn. From the point where the pipe laying commenced on the natural lake bottom the pipe is held in place by two concrete anchors 2 ft. 6 in. x 2 ft. 6 in. x 4 ft., one on each side of the pipe and held together by a $\frac{3}{4}$ -in. diameter link chain. These anchors are placed 20 ft. apart out to the crib. Work on the intake commenced on June 14, 1921, and was completed on September 9, 1921. Inspection of the intake on November 22, 1921, after several heavy easterly storms showed that there was no sign of scour at any point and that the pipe laid in the trench had become buried and throughout its entire length the pipe was resting solidly in place.

The suction well is divided into two compartments by a screen of $\frac{1}{4}$ -in. copper wire mesh through which the raw water passes. This serves to collect any solid particles which may be carried into the well. A $\frac{1}{4}$ -ton Morris travelling chain block is provided for lifting the screens from the well and moving them outside where they are washed by hose pressure.

Low Lift Pumping Station

The low lift station houses 2 vertical single acting triplex plunger pumps, of 300 g.p.m. capacity, each operated by a 30 h.p. slip ring motor. The pumps are connected in parallel and may be operated from the filter plant above by means of a remote control apparatus. Hydro electric power is supplied to the motors at 550 volts. The pumps are of Smart-Turner design.

Two cast iron pipe lines were laid up the ravine a distance of 900 ft. from the lake to the catch basin. Water is pumped up through the 12-in. main to the filters above and the 16-in. main serves to carry off the surface drainage which formerly ran down the gully, and also the wash water from the filters. By carrying the surface drainage water down through this drain and discharging it into the lake it is expected that erosion in the gully will be largely stopped.

A 4-ft. walk has also been built which leads from the catch basin down the gully to the low lift pump house. This is constructed of posts to which are bolted 2 in. x 10 in. stringers on which 2 in. x 4 in. s. are nailed. A railing is also provided on both sides of the walk.

Work Covered by Second Contract

The second contract was awarded in May and included the filtration plant and high level pumping station as outlined in "The Canadian Engineer" dated May 26, 1921.

Work on this contract was begun during the first week of June and steadily progressed to final completion on December 1.

The walls and floors of the suction well, mixing chamber and filters were of reinforced concrete in which super cement was used. The walls and floor of the east filter were poured in one continuous pour. The walls and floors of the mixing chamber and west filter were combined to make one continuous pour. All piping which passes through the walls of the filters was cast in place in the walls.

The concrete walls of the filters are carried above the main floor level and as the specifications called for a continuous pour in the filter walls, provision had to be made for placing the main floor of the building later. This was done by setting the floor beam reinforcing in place and leaving a slot 2 in. deep along the face of the wall to receive the slab. Six inch concrete haunches were also formed into the wall under the beam ends to relieve any shearing tendency of the beam at the wall due to the joint.

The walls above the filters are built of brick. A dark red pressed brick was used outside and buff colored pressed brick inside. The roof over the filter beds is carried on 8 in. I-beams at 18.0 lbs., and is waterproofed with Barrett specification 4-ply tar and gravel roofing. The ceiling in the filter room is sheathed with T. & G. pine. The roof over the pump house proper is carried by frame trusses spaced at 15 in. centres. 8 in. asbestos shingles are used as a roofing material and a 3 course band of red tile around the centre gives it a very pleasing appearance. Metallic ceiling material was used in the pump house.

The pumping equipment at the high level station consists of two centrifugal pumps, one driven by an electric motor and the other by a gasoline motor. The electrically driven centrifugal pump is built to deliver 600 g.p.m. against a total head of 225 ft. and was manufactured by Canadian Allis-Chalmers Co. It is driven by a 60 h.p. squirrel cage, C.G.E. motor. The gasoline driven pump will deliver 750 g.p.m. against a head of 225 ft. and was manufactured by the Goldie & McCulloch Co. It is driven by a 4 cylinder Van Blerck motor of 100 h.p. capacity.

Coagulation Basin

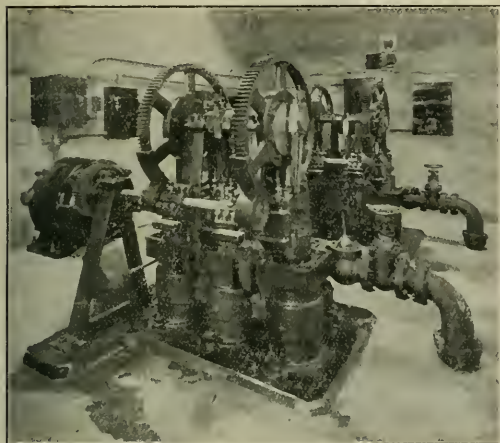
In the construction of the coagulation basin, the special waterproof joint provided for in the specifications was used. This was made by leaving a recess in the floor 6 in. deep to take the walls. This recess was treated with a 3-ply thickness of burlap, each ply being applied with hot asphalt. This type of joint has been found to give very satisfactory results. The walls were carried up in one continuous pour. Baffle walls running longitudinally in the basin were constructed of 2 in. concrete walls at 4 ft. centres. These walls



OPERATOR'S HOUSE—COAGULATION BASIN AND FILTER AND PUMP HOUSE

were constructed as follows: 1 in. x 1 in. angles were used as studding and were fastened by dowels to the floor and roof beams. Metallic lath was securely wired to this studding. Cement mortar containing a small percentage of lime and hair was plastered on to this. To obtain the 2 in. thickness called for, it was necessary to apply 3 coats to each side of the wall, one rough heavy coating, one scratch coating

and one finishing coat. These walls were braced laterally by 2 in. x 6 in. horizontal braces. This was found to make a very rigid job and satisfactory in every way. The baffle walls in the mixing chamber were constructed in a similar manner. In the mixing chamber 1 in. baffle boards are also provided to further mix the water.



SINGLE ACTING TRIPLEX POWER PUMPS

No special features in construction were used in the filtered water reservoir that have not already been mentioned. The special joint between the floor and walls was used there also with success, and the walls were poured in one continuous pour. Since the contract for the filtration plant was let in May, a further contract was let in September for the erection of a 6 roomed house for the plant operator. This was built just west of the filtration plant and is already occupied. It is built of red pressed brick similar to the filter house.

Cost and Summary of Work Done

During the past summer watermain extension work has also been carried on and at present the Township have approximately 19 miles of mains under pressure. Service connections have been installed into 500 homes to the end of December and 425 services are in actual use. All services are being metered, Trident frost-proof meters being used. Lead pipe is used for all service connections to the street line. The standard service is $\frac{3}{4}$ in. pipe.

The cost of work has been as follows:

Watermains	\$311,404.00
Filtration plant	168,464.63
Stand pipe, 90,000 gal. capacity	15,657.32
Total	\$495,525.95

The following were the contractors: Intake, low lift station, mains up gulley and catch basin, Central Foundation Co.; Filtration plant, coagulation basin and filtered water reservoir, Central Foundation Co.; Dwelling house and steps down ravine, Central Foundation Co.; Filter equipment and installation, American Water Softener Co.; Cast iron pipe, National Iron Corporation; Cast iron specials, Dominion Wheel & Foundries, Ltd.; Valves, Kerr Engine Co. and Drummond & McCall, Ltd.; Hydrants, Drummond & McCall, Ltd., and Dominion Steel Products; Standpipe, Canadian Des Moines Steel Co.; Intake pipe, Horton Steel Works Ltd.; Triplex pumps, Goldie and McCulloch Co.; Electric driven centrifugal pump, Canadian Allis-Chalmers Ltd.; Gasoline driven centrifugal pump, Goldie & McCulloch Co.; Chlorinator, General Supply Co.; Venturi meter, Allen General Supply Co.; Alum dissolver, Bannon Co., Ltd.

The following is a summary of the work done:

Watermains laid, 15,521 feet 12 in.; 8,734 feet of 10 in.; 14,116 feet of 8 in.; 60,358 feet of 6 in.
Hydrants set 218.
Valves set 152.
Intake pipe laid, 2580 ft.
Constructed low lift pump house.
Constructed piping up gulley and around plant.
Constructed filter and pump house building.
Constructed one 6-room house.
No. of pumps, 4.
Chlorinators, 2.
Alum machines, 1.
Built walk to lake front.
Built 90,000 gal. steel tank.
Installed 500 services.
Purchased Hunt Club main.
Installed Venturi meter.
The entire works were designed and constructed under the supervision of James, Proctor & Redfern, Ltd., consulting engineers, Toronto.

UTILIZATION OF WHITE COAL FOR HEATING PURPOSES

By A. Langlois

SO far, according to results obtained from experiments conducted in certain countries of Europe, particularly in France, Italy and Switzerland, it is shown that a substantial gain may be obtained in using electricity derived from hydraulic power for the production of steam, as well as its transformation into motive power. The coefficient of utilization of the potential energy of the coal is about 60%, whereas the energy obtained by the use of electricity is about 66%, adding to this that the loss in the production of steam by electric heating is less than by coal.

France is just about to decide on the expenditure of several hundred millions of dollars to completely develop the powers of the Rhone River from the Swiss frontier to the sea, one of the main objects of the scheme being to conserve the coal for industries which cannot operate otherwise. It is said that 1,800,000 h.p. will be available from the Rhone water powers, and which when developed will mean an economy to the country of from 50 to 60 million tons of coal every year, economy in the material as well as on the cost of the production, about \$15,000,000 annually, and to this it is expected to add a saving of over \$20,000,000 more in the use of electricity instead of gas, oil, etc.

In that connection, our country has an immense wealth in store providing, however, that a sound policy of exploitation is designed, in order to make use first, of such water powers which may be developed most advantageously. Canada possesses enough reserve of water power to meet all demands for a great number of years to come, if we compare the amount of power available, some 18,000,000 h.p. at the minimum flow, of which hardly 10% are yet utilized. If the cost of a hydro-electric installation is expensive, the source is inexhaustible through use and with proper development and conservation the yield will never fall.

The present value of the Ottawa Electric Railway lines and equipment within the Province of Ontario and necessary for the operation of the system is \$4,110,922, according to the value set by the Hydro-Electric Power Commission of Ontario.

Building figures for Windsor, Ont., for 1921 show an increase of \$123,270 in value and 100 permits, according to the annual report of Building Inspector Parker. In 1920, 1,109 permits were applied for, the value of which were estimated at \$4,850,010. Last year values jumped to \$5,078,280. This included approximately \$2,000,000, the estimated cost of the new Prince Edward hotel, now nearing completion, and the new police building, and Victoria Avenue Public School.

HYDROGEN-ION CONCENTRATION IN WATER PURIFICATION

Subjects of Coagulation and Filtration Should be More Thoroughly Studied in Light of More Modern Chemical Theories

By Harrison P. Eddy

Metcali & Eddy, Boston, Mass.

THE term Hydrogen-ion concentration, for short written also "H-ion" and "PH," may with sufficient accuracy for popular purposes be paraphrased concentration of acidity or alkalinity, as the case may be. Pure water is neutral, that is neither acid nor alkaline, and its hydrogen-ion concentration is taken at 7. Acidity is designated by numbers below, and alkalinity by those above 7.

The acidity or alkalinity of a liquid has thus far generally been reported in terms of total quantity of acid or alkali present. It has commonly been determined in water by adding acid, or alkali of known strength in sufficient quantity to neutralize the original acidity or alkalinity, the neutral point being indicated by a change in color due to a small quantity of organic dye previously added. But the action of the acid is not due solely to its total quantity but rather to its effective quantity or intensity. The essential difference between this old determination and the new hydrogen-ion method is that the latter shows the intensity, or true acidity, rather than the total quantity of acid.

The function of alum used in the process of water purification is to produce a coagulum, or floc, of relatively large size capable of absorbing or enclosing the finely divided foreign substances which cannot be removed by practicable periods of sedimentation or by filtration at high rates. When absorbed by the alum floc, however, they may be removed readily by sedimentation or by filtration, or by both processes jointly. It is obviously important that the alum introduced into the water be converted into floc as completely as possible.

Why Aluminum in Two Forms is Present in Treated Water

It has generally been supposed that the precipitation of the sulphate of alumina is dependent primarily upon the presence in the water of sufficient alkali and that any excess of alkali likely to be present in waters generally used as sources of water supply is not disadvantageous. However certain experiments indicate that there is an optimum point at which apparently all of the aluminum is thrown out of solution, but that above that point on the side of alkalinity or below on the side of acidity, precipitation is not complete. This offers a plausible explanation of the presence in the water being treated with aluminum both in insoluble and soluble form at the same time and of frequent occurrence of dissolved aluminum in filtered waters. It certainly indicates that it may be highly important, if practicable to carry out the coagulation process at the optimum point of alkalinity—the isoelectric point. Without this determination, or its equivalent, it is impossible to know whether the water has the proper PH. It may be too low or too high for complete precipitation and it will probably only occasionally be just at the optimum point.

The presence of aluminum in two forms is explained by some according to the theory that the alum assumes a colloidal condition, by which is meant a condition intermediate between solution on the one hand and suspension on the other. Thus we may speak of salt dissolved in water, as a solution, and sand or fine silt suspended in water, as a suspension. The soap in soapy water may be taken as a popular illustration of the intermediate conditions—that is, the soap is a colloidal. Some substances, like the alum used in purifying water, may be in, or be changed into, any one of these three conditions. The change is one of condition rather than of composition.

Another theory is that the alum may exist as different chemical compounds some of which are soluble and others insoluble.

Whichever of these theories may be accepted, the important point is that the alum can be converted completely

into insoluble aluminum hydrate only within a narrow range of hydrogen-ion concentration, which is not indicated by the methods commonly used for determining alkalinity, and that either above or below this zone the aluminum or a portion of it, may be present in solution.

A New Step in Water Treatment

It follows, therefore, that it is as important to reduce an alkalinity which is too high as to increase an alkalinity that is too low. This introduces a step in the process of the treatment of water, which is not common and which may prove of material value.

It is hardly necessary to point out the fact that the hydrogen-ion concentration appertains to the condition of the water for satisfactory coagulation and is not a method for determining the quantity of coagulant required. This must be done as an entirely independent step in the process.

For ascertaining the isoelectric point the determination of the hydrogen-ions affords a convenient and practical means. This may be accomplished in a manner similar to that long used for the determination of the total quantity of acid or alkali present. Thus by the use of several indicators constituting virtually a scale of indicators and by the addition of the proper quantity of alkali, or other compound it is possible to bring the water to the exact hydrogen-ion concentration required for complete precipitation of the aluminum from the alum added to the water. Theoretically this may be so minutely controlled in practice as to prevent the occurrence of dissolved aluminum in the presence of the insoluble aluminum floc.

As the conductivity of water varies according to its hydrogen-ion concentration this value may be determined by means of electrical apparatus which indicates the relative conductivity of the water under examination.

Steps for Control of Chemical Treatment to Take Advantage of "PH."

In order to take advantage of the hydrogen-ion concentration in the operation of a water purification plant it will be necessary to control the chemical treatment according to several steps, such as

1. Determine the quantity of alum required for successful treatment under conditions prevalent at the time.
2. Determine the P.H. of the water to be treated.
3. Determine the quantities and kinds of chemicals to be introduced, in order to bring the water to the isoelectric point for coagulation of the aluminum.

The procedure, then, would consist of adding the proper kinds and quantities of chemicals to produce the isoelectric point and the required quantity of alum for the successful treatment of the water.

The quality of most raw waters varies from time to time—often materially within very short periods of time. This variation may be in bacterial content, organic matter, numbers of micro-organisms, turbidity, temperature, or in all of these. It is obvious, therefore, that the quantity of alum must be varied to meet the conditions at the time. It is highly probable, also that the PH varies greatly and that the kinds and quantities of chemicals used to produce the isoelectric point must be varied accordingly. Even if the PH of the raw water remained constant, the necessary changes in the quantity of alum introduced would make it necessary to vary the chemicals required for producing the isoelectric point, as this condition must be fixed with reference to the quantity of alum used, or in other words, if coagulation is to be complete the water must be at the isoelectric point after the sulphate of alumina has been added.

It has been suggested that the PH of the water be determined and the application of the conditioning chemicals regulated automatically by electrical apparatus. Such equipment would greatly simplify the control of the process.

Possible Advantages from PH Control of Purification Plants

Among the advantages which may possibly result from PH control of water purification plants, may be mentioned the following:

1. Prevention of passage of alum through filters and after-precipitation in mains: The passage of alum either in solution, or as a colloid, through water filters has long been recognized as one of the defects of the alum treatment. Such water is not satisfactory for domestic consumption and is objectionable for certain industrial uses, such as dyeing. It may be possible by chemical treatment to so adjust the PH as to secure complete precipitation of the alum and prevent its passage through the filters.

2. Prevention of corrosive action: It is possible that the treatment of the water to secure the isoelectric point, will reduce the danger of corrosive action by the filtered water, due either to the presence of dissolved aluminum sulphate or to excessive carbon dioxide. The treatment required to produce the isoelectric point in some cases (where acid is required) might not reduce—in fact, it might actually increase—the amount of free carbonic acid present in the water. It does not follow, therefore, that in all cases advantage can therefore, that in all cases advantage can be taken of reduction of both of these corrosive substances, although it may be possible to so adjust this treatment as to accomplish this. It is conceivable and has been suggested, that in practice water treated in this manner might become more highly corrosive than that treated in the ordinary way.

3. Control of small plant and animal life: It has long been known that the growth of microscopic organisms and bacteria is favored by the concentration of acidity, within certain limits outside of which there is an inhibiting effect. It has been suggested that by securing the optimum PH for precipitation of alum, the environment of such organisms may be so changed as to prove detrimental to them and inhibit their growth. There is scarcely any definite information on this point and it is included herein merely as a suggestion of possible means of controlling growths in filter plants, which in some cases have been quite troublesome.

4. Possible reduction in size of filter plant: It is a matter of common knowledge among chemists that precipitates formed under certain conditions settle and filter much more readily than those formed under other conditions. There seems to be ground for the belief that alum precipitated at the optimum PH point may form a floc which will settle more readily and permit of more rapid filtration than similar floc formed at a less favorable PH. Should it prove that coagulation at the isoelectric point will produce a floc which will coagulate and settle more readily and permit of a higher rate of filtration, a corresponding reduction in size of coagulation basins and filters might prove a substantial advantage. While it is conceivable that the change in the character of floc, due to PH control, might warrant a change in the depth of filtering material or in some other detail of construction, this does not appear at all probable.

5. Possible increase in efficiency of operation: If coagulation at the isoelectric point will result in the formation of a better floc and in avoiding the passage of dissolved aluminum through the filters, it may be that the bacterial efficiency of filtration will be improved to some extent. It seems reasonable to expect such a result from observation of the process of coagulation.

While these and perhaps a number of other advantages of the PH control may be possible from a theoretical point of view or may be obtained in the laboratory, it is important to prove to what extent, if any, they can be secured in the practical operation of water purification plants.

There is little doubt that the determination of the hydrogen-ion concentration will permit of a more intelligent study of the water and the reactions taking place during its treatment. This fact alone is sufficient to warrant making a thorough investigation of the subject and determining the PH value in many cases.

It is impossible that the methods of control now in use, based in part upon the older conceptions of the chemistry, involved and in part upon practical operating expenses, permit of as close operation of purification plants as it is possible to obtain, even with the assistance of the more delicate and refined hydrogen-ion determinations made in accordance with the latest theories of chemistry.

It often happens that empirical methods lead to practical results which are as satisfactory and effective as those based upon more accurate knowledge. This fact, however, does not justify disregard of progress in science and of new theories. It cannot be gainsaid that the older practitioners in any profession, or in the arts, are inclined to adhere to the older methods and processes as a result of their familiarity and experience with them and a natural reluctance to adopt new ideas. The older members of the profession should constantly guard against this tendency, in order that valuable improvements may not be ignored, simply because they involve new discoveries and new theories.

While it is wise to give proper weight to the reasonable doubt of success in order not to be misled by theoretical consideration, it is certain that the subjects of coagulation and filtration should be very thoroughly studied in the light of the more modern chemical theories. Such investigations will lead to a better understanding of the chemistry of coagulation than that which has governed this important subject in the past. With improved conception of the process advantages of more or less importance are likely to follow. The true value of the hydrogen-ion determination can only be learned through investigations covering a great variety of conditions encountered at a large number of plants.

Such investigations may well lead to a restudy of the whole subject of chemical treatment of water and improvements may result in lines entirely apart from the hydrogen-ion determination, which furnished the initial incentive for such further study. Paper read at the New England Water Works Association Convention, Sept. 15, 1921.

FRENCH TIDAL POWER SCHEME

THE construction of a tidal power-station on the estuary of the Diouris, a small stream which enters the sea at Aber Vrac'h, in Finistere, about 15 miles north of Brest, is proposed by the Societe Financiere pour l'Industrie.

The plans involve the construction of three reinforced concrete caissons in the middle of the estuary, together 70 metres wide. The largest, in the centre, will contain the turbines; its bottom will be 13.20 metres below standard water-level, and its top 12.80 metres above, or 4.30 metres higher than the level of spring tides. Flanking this caisson on each side will be two smaller ones, to contain sluices. The caissons will be connected to each shore by masonry walls, giving the barrage a total width of about 150 metres. A lock will permit the passage of ships.

The turbines installed in the central caisson will be of the Escher Wyss type, designed to generate while running in either direction, to block the passage completely or act as sluices, and to operate as pumps. On a rising tide the water will flow from the sea into the inner basin through the turbines, and when the level of the water is the same on both sides of the barrage, the turbines will be stopped, until with the ebbing tide the level of the sea falls sufficiently to enable them to be operated again with the water from the basin. In addition there will be a second reservoir, constructed on the Diouris just above the limit of the tidal range, to feed a second generating station. It is estimated that the tidal turbines will supply about 7,900,000 kw. hours, of which the industrial load will absorb 5,500,000 kw. hours. The surplus will be employed in pumping water into the upper reservoir, the station in connection with which will furnish 3,900,000 kw. hours.

Co-operation between the police officials and the safety committee of the city of Hamilton and the Chamber of Commerce is needed to overcome conditions here. It was pointed out by interested council members recently when announcement was made that Magistrate Jelfs had practically disregarded the safety zones, stating in effect that people waiting for cars should stand on the sidewalks. The city intends to either have the zones respected by the court and motorists or do away with them entirely.

ENGINEERING STANDARDIZATION

Progress of Standardization in Europe and America Outlined
in Address Before Engineering Section of American
Association for the Advancement of
Science, at Toronto

By R. J. Durely

Secretary, Canadian Engineering Standards Association

ACCORDING to Webster, a "standard" is "that which is established as a rule or model by authority of public opinion or by respectable opinion or by custom or general consent." Standards in engineering work, in conformity with this definition, are thus the result of agreement as regards dimensions, methods of construction, or qualities of material, such agreement being entered into by producers and purchasers for their mutual advantage.

The aim of engineering standardization as we understand it, is to secure this agreement between producers and purchasers in order to effect economy and improve engineering material by eliminating unnecessary sizes and types of parts, or grades of material, or methods of testing for acceptance, by securing interchangeability of parts, lessening the expense of production, and protecting the purchaser by ensuring standard quality.

Basis of Expressed Need

It is important to note that the inception of such standardization work should result from a strongly felt need on the part either of the manufacturers or the purchasers, and it has been found advisable by practically all of the existing standardization bodies to arrange that work on a given subject shall only be undertaken on request from some responsible party. The essential features of the work are, therefore, expression of the need, full discussion between all parties interested, thorough investigation of the problem, the formulation of definite proposals, their criticism by the industries concerned, their amendment and final adoption by an authoritative central body.

The active support of the industries concerned is indispensable and any idea of the compulsory introduction of certain standards is quite foreign to the scheme. Periodical revision is necessary to keep abreast of progress and care must be taken to avoid any decisions tending to limit freedom and individuality in design. From time to time when questions of engineering standardization are being considered it is objected that the proposed action may have the effect of stereotyping the product, thus hindering, rather than facilitating, progress and economy. There would be some force to this objection if, for instance, standardization work were carried so far as to endeavor to get all firms to build to the same design in the case of a complete machine, or if there were no provision for periodical revision of standards, as a rule it is the details that are standardized. There are, nevertheless, cases where the general features of certain types of machine have been standardized with advantage. An example of this arises in the case of the series of standard types of locomotive which have been adopted for the various railways in India.

Scope of Standardization

In Canada, as in some other countries, popular uncertainty seems to exist as to the meaning of the term "Standardization," some taking it as referring to the work considered in this paper, namely, the preparation of such design, dimensions or specifications in industrial manufacturing and construction work as will be generally accepted and worked to by all concerned, and others taking it to mean only the work of measuring, calibrating, or comparing scientific instruments, measures of length, etc. The latter use of the word covers, of course, the very important work carried on by such bodies as the International Bureau of Weights and Measures or the Bureau of Standards, but work of this kind does not come within the scope of the engineering standardization bodies dealt with in this paper, nor do these bodies as a rule deal with the formulation of standards which require endorsement by legislative action.

The economic and industrial significance of industrial standardization has been well pointed out by Dr. Agnew, who, in a recent address on the subject, makes the following clear statement:

"If standardization is carried out on a sound engineering basis:

1. It enables buyer and seller to speak the same language, and makes it possible to compel competitive sellers to do likewise.

2. In thus putting tenders on an easily comparable basis, it promotes fairness in competition, both in domestic and in foreign trade.

3. It lowers unit costs to the public, by making mass production possible, as has been so strikingly shown in the unification of incandescent lamps and automobiles.

4. By simplifying the carrying of stocks it makes deliveries quicker and prices lower.

5. It decreases litigation and other factors tending to disorganize industry, the burden of which ultimately falls upon the public.

6. It eliminates indecision, both in production and utilization — a prolific cause of inefficiency and waste.

7. By focusing on essentials, it decreases selling expense, one of the serious problems of our economic system.

8. By concentrating on fewer lines, it enables more thought and energy to be put into designs, so that they will be more efficient and economical.

9. It stimulates research, to which it is closely allied.

10. It is one of the principal means of getting the results of research and development into actual use in the industries.

11. It helps to eliminate practices that are merely the result of accident or tradition, which impede development.

12. By concentrating on essentials, and the consequent suppression of confusing elements intended merely for sales effect, it helps to base competition squarely upon efficiency in production and distribution, and upon intrinsic merit of product."

The intimate connection of engineering standardization work with research should be emphasized, for in almost every case it will be found that during the process of developing or formulating all engineering standard, technical or scientific questions will arise which can only be settled by investigation and research, the information gained in which is frequently of the greatest possible benefit to the industry concerned.

Standardization in Great Britain

The British Engineering Standards Association was the first central body to be established for the work of engineering standardization. It was founded in 1901, one of its earliest tasks being to obtain agreement and reduce the number of unnecessary sizes as regards standard sections of structural steel and rails as produced in Great Britain. The B.E.S.A. has now published nearly 150 reports and specifications covering practically the whole field of engineering work, and its standards receive wide acceptance in Great Britain. The subjects dealt with, for instance, include such varied items as cement, rolling stock material, forgings, electric meters, locomotives for Indian Railways, incandescent lamps, electric cooking ranges, ball bearings, and a host of others. Since 1917, its activities have developed rapidly and the scale of its operations is now such that it has over 300 working committees with nearly 2,000 members. During the war the B.E.S.A. was able to render important technical service especially in connection with naval and aircraft work. It was, for instance, called upon by the Air Ministry to organize committees and frame a series of specifications for aircraft material, which work was successfully carried out. In doing this, a large amount of research was initiated, especially in connection with novel methods of construction, the action of glue in glued joints in ply wood, and innumerable questions connected with fabric for aeroplane wings and the action and kind of dope.

The affairs of the B.E.S.A. are directed by its Main Committee, composed of members nominated by the great technical societies which support the association, as well as certain other co-opted and ex-officio members. The Main

Committee appoints Sectional Committees, dealing with various divisions of engineering work, and the sub-committees on which producers and purchasers are directly represented and which carry out the actual technical work of formulating the various standards. These are, of course, approved by the Main Committee before publication.

An interesting feature in the work of the B.E.S.A. is the series of local advisory committees, established in Brazil, Chile, Argentina, India, South Africa, China and elsewhere, keeping the parent association informed as to the industrial needs which develop in the various countries and advising as to the suitability or otherwise of British standards for local use. The C.E.S.A., though a completely independent body, has undertaken this duty as regards Canada.

Progress in the United States

In the United States, the movement began about the same time as in Great Britain, but was carried out directly by important technical societies like the American Institute of Electrical Engineers and the American Society of Mechanical Engineers, the former of which began its standardization work in 1898. In 1918, more than 100 American technical societies were engaged independently on engineering standardization work, but there were no systematic methods of co-operation and in that year the American Engineering Standards Committee was organized to unify the methods adopted, to secure united action, and to avoid over-lapping, serving also as a central source of information and dealing with questions of international standardization. The A.E.S.C. is composed of representatives appointed by the member bodies; it does not itself prepare standards, but receives and adopts those formulated by various sponsor societies. Its activity has led to rapid development in many directions, especially in connection with safety code work.

The American Engineering Standards Committee itself, usually referred to as the Main Committee, is composed at present of 47 members, representing 17 member-bodies. The Committee does not duplicate the work of other organizations. On the contrary, in acting as a clearing-house for standardization, it eliminates duplication, as very substantial results have already shown.

The Main Committee is solely an administrative and policy-forming body, and does not pass upon the technical details of standards. The formulation of a standard is in the hands of a working committee, technically called a "sectional committee," made up of representatives designated by the various bodies interested. The Main Committee must approve the personnel of each sectional committee, as being authoritative and adequately representative of the various interests concerned. Producers, consumers, and general interests are to be represented on every sectional committee dealing with standards of a commercial character.

European Standardization Developments

On the continent of Europe, national standardization bodies have been organized in Belgium, France, Germany, Holland, Austria, Czechoslovakia, Italy, Norway, Sweden, and Switzerland. Action along the same lines is being taken in Australia, and Japan has just appointed a Standards Committee as one of its government departments, in this respect following France. In all other countries than France and Japan, the standards committees are voluntary organizations, enjoying, however, a larger or smaller amount of government support.

The Association Belge de Standardisation (A.B.S.) was formed in 1919 under the auspices of the six large engineering associations in Belgium. The delegates of the supporting institutions form its general committee and the standards drawn up by its technical committees are published in draft form for criticism before adoption. Up to date seven publications have been issued, the most important of which are specifications for steel structural work and bridges, and standard requirements for electrical machinery.

In France, the national standardizing body is the Commission Permanente de Standardisation (C.P.S.) a body appointed by and working under the Ministry of Commerce and Industry. The Commission is assisted by the work of

the necessary competent technical advisers with whose aid it prepares projects or proposals for standards, which are submitted to public criticism, and which, after amendment and approval, are definitely adopted as French standards. These standards are obligatory for use in connection with all government contracts, and the scope of the Commission's work includes not only mechanical questions but also those relating to materials and rules for construction. Up to September, 1921, the French Standards Committee has issued upwards of thirty standard specifications.

Standardization in Germany

The amount and quality of the work done in Germany calls for special notice as the standardization movement in that country appears to have the support and interest of industrial associations and manufacturers to an extent which has hardly been approached elsewhere, even in Great Britain or the United States.

Prior to the war, a good deal of electrical standardization work was carried out in Germany by the Society of German Electrical Engineers, but it is understood that the stress of war conditions led to a great development of this work and its extension to other fields of industry, and ultimately, in December, 1917, to the foundation of the Standards Committee of German Industry (N.D.I.) which was organized to serve as a central body for the issue of engineering standards of all kinds.

The German Standards Committee has carried on its work with great activity, having, since 1917, issued some 150 sheets of approved standards, while over 500 sheets have reached the stage of being published for criticism. The German Standards Committee has, as its members, Government departments, technical and industrial societies, the great engineering schools, and also private firms, all these subscribing to its funds. Its Main Committee is made up of representatives nominated by the member organizations and is charged with the general direction of policy and the approval of published standards. The actual executive work is entrusted to an executive committee of twelve members. The German Standards Committee maintains a very complete office organization, having an adequate engineering and technical staff, as well as some thirty other employees in the business office. Great stress is laid on the importance of having a central technical office so that working committees may be relieved as far as possible from the detail work of drawing up the various proposals, collecting information, and putting it in shape for consideration. The central office also takes care of secretarial work and deals with questions relating to finance, publication and the sale of published standards.

An interesting feature of the German work is the co-operation with the N.D.I. of the various important technical associations such as the Society of German Electrical Engineers, the Society of Merchant Shipbuilders, etc., these Associations, in many cases, maintaining their own standards committees for working purposes, but publishing their work through the agency of the N.D.I. and retaining close connection with that body in all cases. In this way, it seems that overlapping and duplication of work is practically avoided, while the interest of the members of the industrial associations in standardization work is effectively stimulated.

Very complete arrangements are made with regard to the publication of German standards, there being available for this purpose a periodical or magazine dealing with production engineering and issued by the Society of German Engineers, in which all proposed standards are published for criticism before being finally approved. No small portion of the work of the technical office consists in the reception and consideration of these criticisms and the incorporation of the necessary amendments in the various proposed standards.

As an evidence of the wide-spread interest of industrial Germany in standardization work, it may be noted that over seven hundred firms are subscribers to the funds of the German Standards Committee, and their business office deals with 1,500 pieces of mail per day.

While it has been found necessary to withdraw and amend a number of the standard sheets, it appears that the majority are adopted and worked to by the leading firms of the country.

Activity in Holland

In Holland the Main Committee for Standardization in the Netherlands was organized in 1916 by the Society for the Promotion of Industry and the Royal Institute of Engineers. Its general organization includes an executive committee, the necessary working committees, and a central standardization office, whose staff comprises the necessary technical and business employees for the effective carrying on of the work of the committee. The committee is supported partly by grants from the Dutch government, and partly by a fund to which many of the large industrial and engineering firms have liberally subscribed.

The Dutch committee lays particular stress on the necessity for thorough criticism of proposed standards before their adoption, and when tentatively approved by the Main Committee, proposed standards are published for this purpose in the Dutch technical periodicals, interested parties being requested to forward such criticism or suggestions as they think advisable. At the expiry of a specified time, the criticisms are considered by the working committee which has prepared the standard, which is amended, if thought proper, and is again sent out to the Main Committee for definite approval and publication.

The work of the Dutch Standardization Committee, like that of the German committee, has so far consisted very largely in the formulation of dimensional standards for engineering work. At the present time seven working committees have been formed, dealing with rivets, bolts and nuts; technical drawings; sizes of paper; methods of lettering; tolerances on cylindrical fits, and screw threads, gearing, shafting, keys, bearings, etc.; cable fittings; sewer pipes; and ship details. Up to May, 1921, 43 standard sheets had been published.

Swiss Standardization

In Switzerland, standardization work was begun in 1918 by the Association of Swiss Machinery Manufacturers (V.S.M.), its standards committee being them intended to deal primarily with mechanical and electrical work. This committee established a practical working organization, but soon saw that the standardization field should not be limited to mechanical and electrical work and, as a result, the Swiss Standards Association (S.N.B.) was organized in January, 1921. This association is a union of some twenty-seven technical and industrial associations and federal institutions, including the Association of Swiss Machinery Manufacturers, the Swiss State Railways, the Swiss Association of Electricians, the Swiss Boiler Owners' Association, the Swiss Society of Engineers and Architects, the Swiss Iron Foundries Association, and other similar bodies. The work so far accomplished in Switzerland has naturally been mainly the result of the activities of the Association of Swiss Machinery Manufacturers although the more extended standardization work of the Standards Committee may soon be expected to develop.

The conditions in Switzerland are of special interest to us in Canada, as, owing to their geographical location and economic situation, Swiss manufacturers are compelled to consider carefully, and adopt in many cases, the standards of neighboring countries. The industrial relationship, for example, between Switzerland and Germany is very similar to that which exists between Canada and the United States. Questions of international agreement are, therefore, of particular importance in Switzerland, and the representatives of the Swiss Standards Committee have been specially active in advocating international agreement in standardization affairs and are keeping in constant touch with the other national standards committees or associations.

In Italy, Norway, Sweden, and Czechoslovakia, while a commencement of the work has been made, development has not proceeded sufficiently far to enable a detailed description of the organization to be given. In each case, however, considerable activity is being displayed.

Work of the C. E. S. A.

As regards Canada, the formation of the Canadian Engineering Standards Association in 1918 took place as a result of suggestions put forward from the British Engineering Standards Association, and its constitution follows generally that of the B.E.S.A. The general policy of the association is directed by a Main Committee of 43 members prominent in industrial and scientific work; sectional committees are appointed, each dealing with one of the main divisions of engineering work and the actual technical work of the association is accomplished by sub-committees each dealing with some one specific task. There are at present ten sectional committees and over twenty sub-committees and panels are engaged in the discussion of the standards which are in preparation. The association is supported by subscriptions from technical societies and firms interested, together with a grant from the Dominion government.

The following publications have been issued by the association:

- No. 1 -1920 Standard Specification for Steel Railway Bridges.
- 1a-1920 Do. (Separate reprint of Material Specifications.)
- 2 -1920 Standard Requirements for Distribution Type Transformers.
- 3 -1920 Standard Specifications for Galvanized Telegraph and Telephone Wire.

The following are in preparation and will shortly be issued:

- Standard Specification for Steel Highway Bridges.
- " " " " Railway Bridges (new edition.)
- " " " " Wire Rope for Mining and Dredging Purposes.
- " " " " Portland Cement.

In order to indicate more clearly the method by which an engineering standard is actually developed, it may perhaps be of interest to take the case of galvanized telegraph and telephone wire, which has recently been dealt with by a sub-committee of the C.E.S.A.

A request from one of the largest manufacturers of this material was placed before the Main Committee in 1919 and indicated that line-wire was being purchased in Canada to a large number of specifications differing very slightly amongst themselves but varying to such an extent that it was impossible for wire rods to be rolled or for wire to be drawn for stock with the certainty of being acceptable to more than one of the large telephone or telegraph companies. It was pointed out that if two or three grades of this material could be agreed upon as fulfilling Canadian requirements, considerable economy would result and material could be promptly obtained from stock. A sub-committee was accordingly appointed to deal with the question, of which representatives of all the manufacturers and all the telegraph and telephone authorities were members. After a preliminary comparison of the existing specifications and the preparation of a draft for criticism, two meetings of the committee were held at which it was agreed that the C.E.S.A. specification for galvanized line wire should cover two qualities of wire and five sizes in each quality. The resulting specification was approved for publication in February, 1921, and is receiving general adoption. The saving resulting from the complete adoption of this specification by all concerned is estimated at from 75c to \$1.00 a ton on an average consumption of eight to ten thousand tons per year.

In the spring of 1921, an important conference of secretaries of the various national standardizing bodies was held in London, at which information was interchanged regarding the methods of work and activities in the various countries represented and a number of points were informally discussed regarding possible lines along which international standardization may be possible. It was felt, however, that international agreement, however desirable, must be approached by slow degrees, although there is every reason to hope that before long, effective action will be found possible in connection with certain important subjects.

SEWAGE GAS AS MOTIVE POWER

By John D. Watson, M. Inst. C.E.,

Engineer to the Birmingham, Tame and Rea District Drainage Board

THE ever-increasing need for power on sewage purification works, the present cost of fuel, the persistent demands for economy, and the salvage of waste products are all influences which compel exhaustive inquiries into every possible source of power.

The object of this paper is to suggest a source hitherto overlooked or minimized, and to describe experiments and experiences which are calculated to stimulate further inquiries into the possibilities of utilizing the marsh gas which is formed by organisms acting upon decaying vegetable and other organic substances.

When the annual meeting of this Institution was held in Birmingham two years ago, the author read a paper on the utilization of sewage sludge, describing in some detail the intensive fermentation process adopted on the Birmingham works in order to render the vast quantities of sludge inoffensive without destroying its fertilizing properties or lessening the calorific value. In that paper comparatively little was said about the gas evolved by the fermentation process beyond making reference to the marked differences between crude sewage sludge before it enters upon the septic or putrefactive stage and the sludge after it has reached that stage. Illustrations were given to show that sludge during the digestion process is lighter than water, but what at first sight appeared to be a reversal of the law of gravitation is a delusion—it is merely an instance of solid matter being held up by gas formed in the course of the putrefactive change which takes place when organic matter is acted upon by bacteria and their enzymes. It was shown how sludge in this condition was more easily pumped than fresh sludge; friction in the process of forcing it through a cast-iron main 5 miles in length was lessened. When the main referred to was first laid difficulties were anticipated which were not realized in practice. It was assumed, therefore, that the comparatively frictionless propulsion of solids through the main was probably due to the reduced density of sludge and to an innumerable number of gas bubbles acting like so many ball bearings between particles of solids, thus tending to reduce the viscosity of the sludge.

It is now proposed to refer to the nature and power of this gas, and to give illustrations of what it can be made to do when under control, for it is possible to harness this veritable will-o'-th'-wisp if the conditions are understood and taken advantage of in a scientific manner.

More than a quarter of a century ago gas generated in Cameron's covered septic tank was drawn off and employed in the Exeter sewage works.

In the beginning of 1920 the author visited the Matunga leper asylum at Bombay, where a small engine had been driven by sewage gas by Mr. James as far back as 1907.

In both these cases the gas was generated in closed septic tanks which favored the cultivation of the anaerobic organisms, and in the latter case the climate was specially favorable. But the work done more recently by Mr. Walshaw at Paramatta in Australia, under what he terms aerobic conditions, is much more remarkable—indeed, it was knowledge of this case coming immediately after his Indian experiences which induced the author to try whether it was possible to obtain equally successful results in this changeable, unreliable climate of ours.

Cole Hall, Birmingham, Plant

The opportunity of making a test at Cole Hall presented itself, and the drainage board, who had some years previously approved plans for driving the pump there by a suction-gas engine, consented to the scheme being carried to admit of a sewage-gas plant being substituted for the suction-gas plant.

It will be observed from the diagrammatic section how very little alteration was required to meet the changed conditions, and how little expense was incurred in defraying the cost of the experiment.

The plant is designed to give a 25-b.h.p. for a working period of six hours per day. It comprises a 34 (max.) h.p. horizontal gas engine of the ordinary suction type, made by the National Gas Engine Company, Limited, a 5-in. centrifugal sludge pump made by the Unchokable Pump Company, a small sludge pump well, and a sludge digestion tank in two sections constructed of cement concrete. There yet remains to be erected a small gasholder, without which it is impossible to keep the engine running for more than an hour and a half or two hours consecutively.

It will be seen from the diagram that the exhaust pipes for the engine are enlarged to 9 in. diameter, and made to pass through the digestion or generating tanks with the object of imparting heat to the sludge and so promoting fermentation, thus benefiting from the experience gained at Saltley, where for a dozen years it has been customary to inject live steam into the sludge during extremely cold weather. It will be observed, also, that provision is made for effecting an occasional disturbance of the mass by injecting compressed air, but this is not altogether satisfactory, as it interferes, to a certain extent, with the regulation of the mixture supplied to the engine, and arrangements will shortly be made to effect the desired disturbance by means of compressed gas drawn from the top of the sludge digestion tanks. This will also serve to mix the fresh charges of sludge.

The principal constituents of sewage gas are methane (CH_4), hydrogen (H), nitrogen (N), and carbon dioxide (CO_2), and it is upon the marsh gas, or methane, we chiefly rely.

Marsh Gas in Sewage: Analyses

The following statement gives the percentage by volume of marsh gas found in various septic sewages in England, America, Australia, and India;

	marsh gas
Exeter (Donald Cameron)	20.13
Exeter (Donald Cameron)	24.4
Matunga (C. C. James)	21.25
Matunga (C. C. James)	23.9
Lawrence (Mass. State Board of Health)	
Septic Tank A	79.0
Septic Tank B	37.5
Septic Tank F	75.9
Parramatta (Septic Gas Co. of Australia)	60.0
Birmingham (J. D. Watson, Aug. 1921)	60.1
Birmingham (J. D. Watson, Sep. 1921)	77.0
Birmingham (J. D. Watson, Nov. 1921)	67.5

The analyses of gas made in September and November respectively are as follows:

	Per cent	Per cent
Carbon dioxide CO_2	18.1	25.2
Hydro carbon HC	0.2	—
Oxygen O_2	0.4	0.3
Carbon monoxide CO	1.1	—
Methane CH_4	77.0	67.5
Ethane C_2H_6	trace	2.8
Nitrogen N_2	3.2	4.2
	100.0	100.0
B.T.U.'s per cubic foot	700	650

Results from such a wide selection of places in different parts of the world seem to indicate that marsh gas is evolved from organic matter as readily in one climate as in another, but in fact it is not so, and the results of the analyses show the need for more definite information and caution in their application. The results obtained by Mr. Rhead, chief chemist to the Birmingham Gas Department, in his analyses of the Cole Hall gas emphasize this statement.

The amount of gas from the total volume of available sludge which can be relied upon at Cole Hall is greater than the power demand there, but it is certain to vary with the seasons, and it is as sure to vary with the age, the volume, and the condition of the organic matter in the sludge. Steps are therefore being taken to investigate the facts with a view to preparing graphs which will show

(1) the volume of gas to be obtained from a given volume of average sludge (10 per cent dry solid matter) in a given time, (2) one which will show at what time the sludge gives off the maximum quantity of gas, and what time is needed to change that maximum into a minimum.

Probably the majority of the results given in the analytical table were obtained from septic sewage, but the

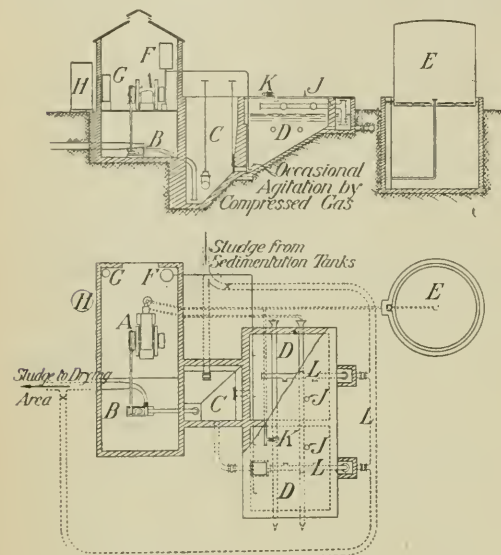


DIAGRAM OF EXPERIMENTAL PLANT

A—34 B.H.P. Gas Engine, B—Centrifugal Sludge Pump, C—Sludge Pump Well, D—Gas-generating tanks, E—Gas holder, F—Compressed gas tank, J—Compressed air for starting engine, H—Cooling tank, J—Relief valves, K—Gas main, L—Supply pipes.

author is of opinion that it is from sludge and not from liquid sewage that gas can be obtained in sufficient volume to render its use economical. This statement is contrary to that put forward by Australian observers who claim that the best results can be obtained from aerobic treatment of sewage.

Up till now the sludge available at Cole Hall has been very watery (containing only 3 per cent dry solid matter). This was owing to the fact that the supply was temporarily dependent upon the ability of a land irrigation pipe laid on a very flat gradient to convey it from the outfall works to the engine house. By a new sludge main which will soon be completed a denser sludge (at least 10 per cent dry solid matter) will be conveyed to the tanks, thus reducing the volume of water which has hitherto entered the tanks, persistently lowering the temperature of the mass, and taking up space which should be occupied by organic matter which is capable of yielding gas. With a more concentrated sludge, it is evident that the gas forming material temporarily confined in the limited space should produce a greatly increased volume of gas (a matter of prime importance until a gasholder is provided as part of the installation), for it is necessary to impound surplus gas to be drawn upon when the demand by the engine exceeds the volume available in the digestion or generating tank.

Notwithstanding existing weaknesses in the experimental plant, the fact remains, that the engine has worked successfully and has given out the power required to drive the pump.

At Cole Hall, where the gas engine has been installed, the method of disposing of sludge has hitherto been quite

different from that obtaining in the main works in the Tame Valley. At the latter works the sludge is subjected to the fermentation process for the reasons enumerated two years ago, but at Cole Hall farmers buy it for agricultural purposes, and it is obvious that so long as it can be got rid of in this—the most satisfactory—way, there is no need to employ intensive fermentation. At Cole Hall, therefore, only sludge required to give off gas for power will be subjected to fermentation, and, judging from the limited experience available, it is estimated that about 2 tons of wet sludge (10 per cent dry, solid matter) per day will be required to provide an explosive gas capable of generating 25-h.p. for a working period of six hours per day. The amount of available sludge at Cole Hall is approximately 80 tons per day (10 per cent dry, solid matter).

The sludge, after it has been discarded, will probably be freer of fat and grease than it was before fermentation, and to that extent it will be more valuable to farmers than it was in its initial stage; moreover, it will still retain about 2 per cent of nitrogen after it has given off its methane, so that its fertilizing properties are not thereby exhausted, if indeed they are materially lessened.

Costs

Before emphasizing the fact that we have in marsh gas a useful power for driving an internal combustion engine, and that we have great volume of this gas in sewage sludge, there is the all-important question, Is it economical to use it?

It is obviously the business of the engineer to determine this, and he will require to take into account comparative costs of fuels, probable fluctuations in prices, the location of the works, transport facilities, effect of strikes on the supply of fuel, &c.

It was originally intended to put in a suction-gas plant, and although it is hardly time to make a comparison which can be relied upon, the following statement will be interesting, and may be helpful:

Annual Cost of Installing a Sewage-Gas Plant Compared With the Installation of a Standard Suction-Gas Plant

Duty—25 b.h.p. for daily period of six hours.

The cost of gas engine, engine house, pump and pump well being common to both plants is ignored in the comparison. The cost of labor, lubrication, and repairs is also approximately equal, and does not appear in the comparison.

Suction-gas Plant

Capital cost of suction-gas plant of similar capacity, £300.

	£	s.	d.
Annual charge on £300 at 10 per cent	30	0	0
30½ tons of anthracite at £3 per ton	91	10	0

(Allowing 1¼ lb. per b.h.p. hour)

	£	s.	d.
Cost of constructing generating tanks, with complete equipment of fittings, and allpewerk £600 at 7 per cent (repayable in 25 years)....	42	0	0
Provision for gasholder, £500 at 10 per cent (repayable in 14 years)	50	0	0
	92	0	0
Net annual saving in favor of sewage-gas plant	29	10	0

Essentials to Success

The following notes should be pondered by those who think of developing the Cole experiment.

Success in designing an installation is dependent on accurate information regarding (a) the percentage of sludge (dry, solid matter) which is capable of gasification, (b) the rate of evolution of the gas at various temperatures, and (c) the proportion of methane in the composition of the gas.

(a) Sludge, like sewage, is of diverse composition; much of its value as a gas producing substance depends upon the efficiency of the grit chambers and the amount of organic matter left in the sludge. There can be no doubt

that the gas comes from the decomposition of organic matter, and an inordinate proportion of inorganic matter would be a distinct hindrance, so would large doses of tarry and oily substances mixed up with the sludge lessen, if they did not entirely inhibit, the gas producing power of the putrefactive organisms.

Again, a modern sewerage system is designed to convey to a place of disposal almost every form of trade as well as domestic wastes, and water is the vehicle by which it is conveyed. That the fouled water contains organic matter is true, but obviously it is the sludge which is brought down with the water that contains the material from which gas is produced, so that the less liquid there is in sludge which is set aside for gasification the better. This, however, leads to a position where one may go wrong very readily. It is most difficult to obtain fresh sludge which contains more than 10 per cent of dry, solid matter, but the author has found to his cost that you may keep such sludge in a tank for a whole year without its undergoing the putrefactive change so essential to the production of gas. It is not enough, therefore, to set aside great volumes of organic matter; that matter must be introduced into a tank which has already been inoculated by the right organism, and it should not be introduced so rapidly that the organisms are smothered.

On the Sattley works where sludge is treated in order to deprive it of smell and its emulsive character, it is found to be advisable to mix the fresh material with about 20 per cent of "ripe" sludge when it is first transferred into a digestion tank; it is desirable also to maintain its temperature as high as possible with the view of providing those conditions which favor putrefactive change. Probably Dr. Travis's hydrolytic tank was the direct result of the desirability of doing this work recently. Dr. Imhoff, the German engineer, improved on Travis's tank and boomed it in America, where it has proved to be a very efficient instrument for separating fresh sewage from sludge which is kept designedly for months in order to convert it into an inodorous mass. The Birmingham method is better adapted to local circumstances, but the results are similar except that the Birmingham method is so arranged that it is possible to isolate sudden rushes of anti-septic liquor, a matter of considerable importance at times.

Another line of investigation essential to ascertaining the volume of gas which may be evolved from a given quantity of sludge is the influence of agitation. We know as a fact that disturbance of the mass is beneficial, but we are ignorant of the extent to which it should be carried. When a silt tank at Sattley fails to ferment, it is passed through the pump and distributed among what are termed ripe or healthy tanks. Breaking up the sludge as it passes through the direct-acting pumps effects a considerable change, but this side of the question requires further investigation, and what has already been done in Australia in this regard should not be overlooked.

(b) Temperature plays a very important part in the rate of evolution of gas and the volume extracted from a given quantity of sludge. In a sewerage district of 115 sq. miles, it takes so long for some sewage to travel to the outfall that it is mildly septic before it arrives there, but when the district is small the liquid portion of the sewage is for the time being almost free of putrefactive tendencies and will probably remain so throughout its treatment. The sludge, too, may take longer to septicize, but if treated under anaerobic conditions should be converted into gas in the quickest and most favorable way. We do not know the temperature at which the organisms will cease to act altogether, nor the temperature at which they will act most efficiently; investigation is required therefore if we would ascertain this one of the essential factors of the problem.

The composition of the sludge also should be considered when endeavoring to find out the rate of evolution of gas. Domestic sewage per se is probably better than any other for gas production, and some sewages, so far from containing putrefactive organisms possess qualities which sterilize those that emanate from domestic sources. Rushes of acid water, for example, affect whatever they come in con-

tact with. One of the Birmingham outfalls is so bad in this respect that in five months a new cast-iron centrifugal pump impeller is pitted all over and the extremities worn to fine points.

(c) The analytical constituents of the gas emanating from the available sewage sludge should be determined with accuracy. The figures in our possession are limited; so far they lead us to say that the gas contains from 60 to 77 per cent of methane, but with frequent determinations taken over a longer period it will be possible to give a more reliable figure.

Conclusion

Members of the institution having seen the installation at Cole Hall will appreciate the following abstracts of facts:

Ordinary suction gas engine	34 (Max.) b.h.p.
Duty of Engine	25 b.h.p. for 6 hours per day
Quantity of gas consumed per h.p.	20 cubic ft.
Estimated quantity of gas required per day	3,000 cubic ft.
Maximum duty of unchokable pump	450 gallons per minute against a head of 36 ft. at about 1,200 revolutions per minute.
Rising main	12-in. dia. Stanton Hume pipe.
Sludge capacity of generating tank	80 cubic yards.
Proposed capacity of gas holder	2,000 cubic ft.
Average proportion of methane in gas	60 per cent. to 77 per cent

The following observations on the working of the plant between September 6 and November 3 of this year, although varying in some respects with our original estimate, are of considerable importance:

Total amount of dry, solid matter passed through tanks	4 tons.
Average period of retention	6.4 weeks.
Average percentage of dry, solid matter in wet sludge	3 per cent.
(The plant now contains sludge having a proportion of 10 per cent dry, solid matter.)	
Estimated amount of gas consumed by engine	25,000 cubic ft.

The total gas yield is, of course, in excess of this amount, but it will only be possible to measure it when a gasholder is available. Under present circumstances a considerable quantity of gas is lost each time a recharge of sludge is made. A certain amount of gas has also been lost in making tests and minor alterations. A gas production of 25,000 cubic ft. from 4 tons dry, solid matter is equivalent to 1 cubic ft. of gas from .36 lb. dry, solid matter, or a gasification of 18 per cent of the total dry, solid matter. This is only 60 per cent of the amount of sludge gasified in open tanks in the Thame Valley.

In conclusion, it is worthy of remark that the fact which has influenced the author more than any other in following up this experiment consists in this: That 400,000 tons of wet sludge containing 27,000,000 tons of dry, solid matter is dealt with on the main works at Birmingham every year, and that as much as 9,000 tons of dry, solid matter is gasified. This is equivalent to 320,000,000 cubic ft. of gas. Paper read at a meeting of Municipal and County Engineers.

Building activity in Kitchener, Ont., during 1921 reached a total of \$932,050, a decrease of nearly \$200,000 from 1920. In this respect, it must be considered, however, it must be considered, however, that in 1920 the Y.M.-C.A. building and several large industrial buildings swelled the total considerably whereas this year \$494,800 or half the total was made up of residence permits to the number of 117. The total number of permits issued was 496.

TRANSPORTATION AND DEVELOPMENT OF MODERN CITIES

By Paul Seurot

Chief Engineer, Montreal Tramways Commission

THE solution of the transportation problem is especially difficult in the cities still at the period of evolution, cities in process of transformation and in which the population has not reached the saturation mark.

London and Paris, so essentially modern, are, however, very old cities which long ago reached their maximum growth and can only expand now by the annexation of ex-centric districts or of suburbs. The transportation problem consists, for those cities, in creating new extension lines to connect the central part of the city to these outlying suburbs in the shortest time. The changes to be made in the urban transportation of these cities will have in view mainly the improvements to be made in the rolling stock, the means to be adopted to accelerate the service, the curtailment of operating expenses practicable with a good service and the possible reduction of fares.

In such cities, the transformations are slow and have but little influence on traffic movements. Custom has assigned certain districts, certain streets to special classes of business and the migration of certain stores or shops towards new quarters is progressive and affects only a small number of customers whose movements in one direction or another is hardly appreciable, in so far as transportation is concerned.

In North America, in Canada particularly, the conditions are different. The large cities, there, are still in the period of evolution and of transformation. Some of these cities, until quite recently, were mere villages or only an agglomeration of wooden shacks hastily put together alongside a railway track, near a mine or a lumber mill.

Montreal itself which, with its surrounding insular territory, had but 330,000 inhabitants in 1900, reached 872,000 last year; and taking into consideration the large territories still unoccupied on the island of Montreal it is possible to foresee what will be the Canadian metropolis in twenty or thirty years.

Special Conditions in American Cities

The rapid growth of American cities has taken place under special conditions and might be compared to the forced growth, in conservatories, of plants, which, normally, would have reached their full development after a much longer time. The construction of railways has been the principal cause of this rapid evolution. In the over-populated countries of Europe, the railways had to follow well determined paths to connect cities permanently settled, and which they could only enter at specified points and under certain conditions and restrictions; this explains the elaborate approaches, bridges, viaducts or tunnels which had to be built in order that the railway construction should conform to the state and municipal regulations.

In America, the conditions were entirely different; a few industrial centres, usually at the confluence of navigable rivers, scattered over the continent, separated by large and usually unoccupied territories, centres which it was necessary to connect with one another. That is why, at the beginning, railways were laid along the path of least resistance, with cheapness and rapidity of execution in view, rather than durability and permanency. Along these railways, which were to become the great arteries of the American continent, were successively erected the warehouse, the general store, the hotel, a few residences, the factory, the church and in a short while towns came to life and expanded with a rapidity at which Europe marveled.

This is why, in so many American towns, can be seen rights-of-way in the middle of the streets, level crossings, sidings and shunting tracks across the main avenues or even along their axis and which are so many obstructions to local traffic and to the development of some districts, with the accompaniment of noise, dust and smoke.

This brought about, within the last twenty-five years, the reconstruction of the principal railways in the large

cities of the United States: the elimination of freight tracks from the surface of the streets, the grouping of the main approach lines, the elimination of grade crossings by depressing or elevating the tracks, the not infrequent amalgamation of the lines of different companies entering a city along the same right-of-way and having the same terminal, the "Union Station," the practical usefulness of which to the interested companies is self evident, and which puts at the disposal of the travelling public all the latest modern improvements, comforts and conveniences.

Interurban Transportation

In regard to interurban transportation, the old and permanently established towns have only to provide the lines that are necessary to serve the large centres of population and the principal streets. The levels are permanently established according to standard data, the pavements, the sewers and all municipal underground utilities have been installed and the tramways and the subways have only to conform to the regulations and to the conditions. The only things to determine are the number of lines to operate, the car service and headway for each hour of the day, the transfer points, the subdivision in zones, the economical haul, the time and the place when, and where, the subway or elevated structure becomes more advantageous than the auto bus or the tramway. The loading and congestion points are known and means to adequately and rapidly handle the crowds at certain hours can be devised in advance: in these cities, the population of which has already reached the point of saturation, the growth is constant and is not generally over 3%. The suburbs alone, which may still be in the period of evolution, are the unknown factors of the problem. These suburbs will have to be served by extensions or penetration lines which will effectively relieve the steam railways suburban traffic which is always an impediment to main line operation.

In cities still in the evolution or constructive period, the problem is more difficult to solve; the development of the means of transportation and the development of the city itself are not always simultaneous; in many cases, particularly during the periods, more or less hysterical, of real estate booms and wholesale lot subdivisions, street car lines, and even elevated lines or subways, are built long before the newly opened territories may be sufficiently developed to insure a precarious return upon the invested capital. In their estimates, the engineers and the financiers, as well, should take in consideration the probable increase in population to have a fair idea of the future density of traffic.

According to the theory of George P. Watkins, one of the statisticians of the Public Service Commission of the State of New York, theory based on former studies by Wellington, in his book on Railway Location, and by Matterns-dorf in Berlin, it appears that, generally, traffic, which at first increases directly in proportion with the population, increases more rapidly, and as the square of the population, as soon as transit improves in regard to speed, comfort, number of cars, even in these improvements require the opening of new lines or the construction of new means of transportation such as subways.

Transportation and Growth of Cities

It might be well here to see what bearing well planned new means of transportation may have on the development of communities. Taking the Borough of the Bronx, for instance, which became, politically, a borough of the city of New York in 1900, remained, until 1905, geographically separated from New York by the Harlem River and about 11 miles distant from the down town district which could be reached only after travelling for nearly an hour and a half.

In 1902, when the construction of the subway was started, the population of the Bronx, spread over an area of 40 square miles, was 230,000 and the real estate value recorded in the Tax Department was \$153,500,568. In 1905, when the east branch of the subway was opened, giving rapid and continuous transportation from the Bronx to South Ferry, the end of the line at that time, the population was 275,000 and the value of the real estate \$274,-

859,593, which shows that in 3 years, previous to the opening, but speculating on the benefits to be derived therefrom, the population had increased 20% and the real estate value 78%.

In 1911, six years after the opening of the subway, i.e. from 1905 to 1911, the population had increased 76% and the real estate value 120%; the former being 483,224 and the latter \$605,222,933. Compared to 1902 the population had increased 110% and the real estate value 294%.

Situation in Montreal

In 1912 the population on the island of Montreal was 600,000; in 1921 it was 872,000. In 1912 there were, on the Montreal Tramways 175 rides per annum et capita; according to Watkins' theory there should have been 369 revenue passengers per annum and per capita; there were only 218 during the last fiscal year. The same discrepancy appears if we take the transfers into account; the total number of rides per annum et capita was 230 in 1912 and 297 in 1920-1921, whilst it should have been 485 according to the formula established by Watkins, Wellington and Matersdorff.

We know, however, that until certain improvements have been brought in any transportation system the traffic is directly proportional to the population; therefore the rides per year and capita which were 175 in 1912 should have been 254 in 1921; they were only 218. The difference, however, is not so great if we consider that the last seven years were abnormal economically as well as in regards to immigration and population.

It would not be right, either to conclude from the above data, that is traffic has not increased more rapidly than in proportion to the growth of population it is because the service was not sufficiently improved to cultivate in the public what has been called the "riding habit."

The cause of this traffic stagnation is not due altogether to the economic crisis which has weighed on the world for the past seven years nor solely to the lack of employment and to the rising cost of life, of materials and of labor; the main cause is inherent to local conditions which obtain in large modern cities in America, still in the constructive period of evolution and transformation and where the utter lack of well planned policy in regard to city development has created unbalanced systems of transportation where we see over congested lines pay for the maintenance of wholly unproductive ones. These conditions are due to the uneven development of the different sections of these cities, creating in some of them some sort of local hypertrophies generally following the energetic, if not always wise, methods employed by some real estate companies too anxious to dispose of their subdivided wilderness. To this may be added the hasty construction of factories and shops in poorly chosen localities and which permanently close their doors after a short while or move to better quarters. To these difficulties, found in the way of satisfactory transportation, must be added the rapid construction of large office buildings within a comparatively small area.

In Montreal, for instance, were built, almost simultaneously, the Transportation Building, the Dominion Express building, the Royal Trust Building, the Duluth Building, the Sauvegarde, the Versailles Building, the Shaughnessy Building and the Bank of Toronto Building; and now we see the office business section of the city expand and its centre of gravity move away from the intersection of St. James and St. Francois Xavier Streets; large office buildings are now being erected on Beaver Hall Hill and on Phillips Square; St. Catherine Street is changing from day to day; large banks are now opening there monumental branch offices; new stores are opened or the old ones enlarged; at the main transfer points are the Dandurand Building, and Almy, and the Drummond Building; to-morrow it will be the Mount Royal Hotel, not to mention the almost continuous line of theatres which at certain hours concentrate, along a distance of barely a mile, crowds that must be handled in a comparatively short time.

Crowded Street Cars

The rapid transportation of the many employees working in these stores and offices and who, from 8 to 9 a.m. and from 5 to 6 p.m. go in both directions like a flood and ebb tide, is a difficult problem to solve and one that taxes the operation of the transportation system to the utmost, owing to its very disproportion with the normal, or base day, service. In Montreal, for instance, at the peak load, during the 6 o'clock rush period, there are on the whole system two and a half times more cars in service than from 10 a.m. to 4 p.m. During this peak load service, the main streets, such as St. James, St. Catherine, Bleury and St. Denis are so crowded that it is practically impossible, particularly near the intersections, to add any more cars. On St. James, between Place d'Armes and McGill Street, there is a continuous line of cars, and on St. Denis, for instance, the average headway between cars is 40 seconds and 32% of cars, passing under that headway, have trailers in tow.

The first and immediate remedy to these conditions, with a view to relieving the congestion and in order to accelerate the car movements, would be to cut down the number of stops or, at least, to stagger them on each side of the streets. This, however, requires, first of all, the good will and the co-operation of the public.

What will be the solution a few years hence? Perhaps the construction of subways under these main arteries making possible an underground express service run in conjunction with, and relieving the local surface service or, possibly, the construction of new surface lines on streets parallel to those on which tramways are now being operated and which could give a mixed service with stops staggered with the present ones.

Subways Would Relieve Conditions

It seems, however, that the better plan would be to follow boldly the American solution and build underground railways which, in so far as Montreal is concerned, should preferably be operated jointly with the existing street railway and under the same management. According to American experience, it seems that the Metropolitan District proper is included within a 30-minute zone; outside this zone, the service becomes suburban and, as such, may be subject to the regulations obtained in the operation of suburban service on main line steam railways, chiefly in regard to time table and headway. However, the contract entered into by the City of Montreal and the Montreal Tramways Co., and under the terms of which the present system is operated, has not accepted this delimitation between urban and suburban travel; the contract, sanctioned by an Act of the legislature, has included in the metropolitan district certain sections of the island separated by great distances so that, for instance, it is possible, to go from Cartierville to the limits of Montreal East, nearly twenty miles, for one single fare, on a trip lasting almost two hours. This feature will perhaps foster the development of vast territories, still unoccupied, in the Metropolitan District, but the means of transportation will have to be organized on a new basis, because it will become impossible to feed from a central point, already too congested, far distant territories which will themselves be, at that time, active and thickly populated centres.

In view of the changes taking place almost continuously, it is necessary to closely follow the increase of population with a view of placing adequate means of transportation at its disposal.

The census of the population bordering along the main arteries must be taken and details given for each office building, department store, factory or theatre. In the questionnaires sent to the managers of large stores or manufactures, information is asked regarding the routes followed by the employees in going to or from their work; such data help in planning what service is to be given to the travelling public at certain hours of the day. The returns so obtained can be shown on the plan of the city by plotting, isometrically or in any other conventional manner, the density of population for each street and even for each block.

With due allowance for the annual percentage of increase in population and the possibility of seeing St. James Street and Notre Dame Street lined with ten-storey office-buildings between McGill Street and the Champ-de-Mars, one may imagine what service would be required to handle the crowds of employees leaving this busy bee-hive between 5 and 6 o'clock; and this increase, with attending congestion, will not only be local but will spread to, and effect, the other large arteries of the metropolis.

Divide Cities Into Districts or Zones

In some American cities, with a view to obviate this overcrowding, it has been recommended that stores and offices, on different blocks, should close at different times; this solution, however, is not practical. Even before the congestion has reached the point of saturation, it seems that the only possible solution will be the construction of subways or of new surface lines looping the principal centers of congestion; at that time, the routing of the main lines should be so changed as to rapidly handle the crowds from the most heavily loaded district towards the limits of districts in which the density of population is constantly decreasing. This is equivalent to zoning; the division of Montreal in zones, with the present rolling stock, could be done only in so far as the rapidity of transportation is concerned, a greater number of cars reaching the limits of the first zone being able, by means of loops, to come back to the starting point. The division in zones, in so far as it might affect the fares, by making the tariff proportional to the haul, would necessitate an entirely new equipment or the remodelling of the present rolling stock. This zoning, however, is impossible according to the contract which specifically determines the limits of a uniform tariff territory.

As to new lines, called extensions in the contract, they should be considered, in regard to population, as are the central districts of the city. A careful census giving the number and the class of houses, tenements and residences, with the number of people residing in the district under consideration, should be prepared, affected by a co-efficient corresponding to the probable growth of the district. The construction of the new line or extension should begin when the development of the district had reached a well determined point.

Co-operation in Planning Street Car Routes

In this respect, there should be the greatest possible co-operation between the city and the Transit Company; this co-operation would then prevent the city from compelling the operating company to immediately build lines which will likely be unproductive and remain a burden on the rest of the system for many years; this co-operation would be such as to avoid, what is done repeatedly: ordering the construction of new extensions in the wilderness, along non-existent streets which appear only on city maps and through land which has not yet been expropriated. This method has, furthermore, the fault of carrying with it unnecessary expenses since the tracks have to be reconstructed when the streets are at last opened and the sewers, gas and other municipal improvements installed. It has also the fault of laying a new line on a right-of-way which cannot be reached as long as the cross streets have not been opened up. On a new line, recently built under such conditions, passengers wishing to get on or from the cars can only do so by jumping over fences and trespassing on private property. It seems that a well thought out plan should foresee the simultaneous construction of the streets, of the subterranean municipal improvements and of the street car tracks.

In regard to the Island of Montreal, the construction of new lines serving municipalities outside of the territory already specified in the contract seems difficult to undertake. According to the present contract entered into by the city and by the Montreal Tramways Company, every municipality served by the Company should be able to support its own share of the cost of operation of the transportation lines necessary to handle its quota of traffic, without being a load on the city of Montreal or on the other munici-

palities served by the same system. This clause of the contract is perfectly fair and reasonable. It prevents, as a consequence, the construction of new extensions into the several municipalities surrounding the Metropolis, on the island of Montreal, because such lines could only be operated if the interested municipalities were able or willing to guarantee the fixed charges and operating expenses which could be met only by prohibitive fares. It seems that in such cases the construction of the proposed extension must be postponed until the time when the population will be large enough to ensure an adequate and sufficient revenue.

In concluding, it is well to insist upon the necessity of co-ordination between the several municipal departments and the transportation system; more particularly in regard to street tramways this co-ordination must have in view the simultaneous changes of grades, renewal of pavement and renewal of tracks in the central sections of the city; in the outlying districts and the suburbs, and after a careful study of the possible normal development of any district, it will be wise to build the new extensions or transportation lines only after all the preliminary planning will have been settled, after all the expropriations will have been concluded and after all municipal improvements, streets, sewers, water and gas mains and electric conduits have been constructed and installed.

With a view to improve its service and to help in giving to the city in which its lines are laid, the poise, the symmetry, the quiet orderliness, the regularity and harmony that go toward making the distinction of well governed cities, the transportation Company should endeavor to do away with anomalies and conditions which may not be abreast of the times; it should replace all unsightly wooden poles by steel or reinforced concrete poles which, with the advantage of durability, easily lend themselves to some sort of decoration; it should try to unify the types of rails, of track construction and of the cars; it should provide shelters and loading platforms for the passengers at the main transfer points and generally should endeavor, with the hearty co-operation of its personnel, to foster among the public the riding habit which alone can ensure the success of any transportation enterprise.

This result ought to be easily obtained in Montreal where the present contract has made partners of the city, that is the public, on the one hand, and of the Transportation Company, on the other. Paper read before the Town Planning Convention, Montreal, Sept. 29, 1921.

CORRECTIONS IN REPORT OF MEETING OF ENGINEERING SECTION, A.A.A.S.

Certain typographical errors, incident to the change of form and date of publication unfortunately crept into the report of the meeting of the Engineering Section of the American Association for the Advancement of Science appearing in our issue of Jan. 3. The title of Dr. Heymans' address should have read "Optical Determination of Stress Distribution in Engineering Problems"; the temperature above which the metal parts of hydraulic installations should be kept a fraction of a degree was stated by Mr. Murphy as 32 deg. F.; "electrically" in the sixth line of the second paragraph of the report of Sir Adam Beck's address should read "electricity"; in Prof. Brown's comments on the address by Mr. Harris, the second sentence should read "Engineering courses in Canada should be primarily technologic"; and in President Howe's comments on the same address, near the bottom of the first column of page 110, the first sentence should read, "President Howe expressed a fear lest the present trend toward the adoption of courses in business administration might be overdone."

Archibald & Holmes, general contractors, Toronto, have moved their head office from the Continental Life Building to 709 Yonge St., Toronto.

C. E. Hogarth will present a paper before the Montreal Branch of the Engineering Institute of Canada on "Principles of Water Softening," on January 26, 1922.

AMERICAN CONCRETE INSTITUTE CONVENTION

THE following tentative program has been arranged for the annual convention of the American Concrete Institute which will be held at the Hotel Winton, Cleveland, February 13-16 inclusive.

MONDAY, FEB. 13

Registration (11 a.m.)

Meeting of Committee on Committees. (Chairman of all Committees to discuss future work of the Institute.)

Concrete Roads (2 p.m.)

Report of Committee S 6 on Concrete Roads. Presentation and discussion of revised standards, Clifford Older, Chairman. Discussion of Plant and Material Handling Problems. Moving Pictures.

Concrete Houses (8 p.m.)

Report of Committee S 5 on Reinforced Concrete Houses (New Building Regulations), E. G. Perrot, Chairman.

Papers and addresses by two or three builders of Concrete Houses—no theory—no guesswork—no untried conjectures—actual experience on how it is being done. One of these addresses will be by Miss Kate Gleason, Rochester, N.Y., whose concrete houses are close to the hundred mark—all sold—at a profit.

TUESDAY, FEB. 14

Research (9 a.m.)

Report of Committee E 3—Research. W. K. Hatt, Chairman. A survey of important research which is being undertaken by various agencies and of research for which there is need.

Presentation of the Wason Medal. Sanford E. Thompson, Chairman Committee G. 5. Response.

Announcement of the work of Committee G 3 on Form of Standards, by the present.

Business Session. Report of Board of Direction, by the secretary. Appointment of Tellers to canvass ballots for Officers.

Concrete Products Manufacture (2 p.m.)

Report of Committee P 1 on Standard Concrete Building Units (New Standards for Block, Brick and Structural Tile. R. F. Havlik, chairman.

Report of Committee P 5 on Fire Resistance of Concrete Building Units. Lesley H. Allen, chairman.

Report of Committee P 4 on Concrete Staves (special reference to strength and testing.) Walter Brassert, chairman.

8 p.m.—Report of Committee J 2 on Concrete Pipe. B. S. Pease, chairman. Institute Representation.

Report of Committee P 7 on Concrete Pipe, Drain Tile, and Conduit. C. F. Buente, chairman.

Report of Committee P 6 on Products Plant Operation. S. H. Wightman, chairman, leading a general discussion of Plant layout, equipment and operation problems.

WEDNESDAY, FEB. 15

Engineering Design and Inspection (9 a.m.)

Report of Joint Committee on Concrete and Reinforced Concrete—presented by reference to preprints previously distributed. S. C. Hollister, chairman Institute representation. The report will be discussed by major subjects, led by Chairman of Local Committees of Contractors from New York, Boston, Philadelphia, Chicago, and elsewhere, and by Chairmen of Institute Standing Committees whose work involves a special consideration of subjects covered in various section of the Joint Committee Report. The discussion will be centered chiefly upon the subjects in the following outline:

1. Quality of Concrete—Proportioning, Mixing, and Placing (Chapters III, V, and VI). Chairmen Local Contractor Committees and N. M. Loney, chairman, Committee C 6.

2. Details of Construction—Fireproofing and Con-

struction Joints (Chapter VIII). C. R. Gow, chairman, Committee E 4.

3. Waterproofing—Protective Treatments. (Special reference to Corrosion of Steel Reinforcement) (Chapter IX.)

Business Session (11:45 a.m.)

Remarks by Retiring President. Announcement by tellers of new officers. Induction of new officers.

2 p.m.—(Continuing discussion of Joint Committee Report.)

4. Surface Finish (Chapter X.) J. C. Pearson, chairman, Committee C 3; N. M. Loney, chairman, Committee C 2.

5. Design (Chapter XI) with particular reference to Proposed Design Requirements on Cost of Construction. A. R. Lord, chairman, Committee E 1 and Chairmen Local Contractor Committees.

8:30 p.m.—An informal, social, get-together, with cider and doughnuts. Here's your chance to button-hole somebody and "tell him" or "ask him."

THURSDAY, FEB. 16

Practical Field Problems (9 a.m.)

A study of Proportioning Materials and Consistency, Slump Tests, Test Cylinders.

A demonstration of sieve analyses of aggregates, water control, slump tests and casting test cylinders as a means of relating laboratory knowledge to Field Methods.

Report of Committee C 1—Contractors Plant. R. C. Wilson, chairman.

Report of Committee C 2, Concrete Floor Finish—Presenting Simplified Standard Specifications, followed by two brief papers on Special Floor Finishing Methods.

2 p.m.—Report of Committee C 3 on Concrete Surfaces. J. C. Pearson, chairman.

Changes in Stucco Practice. Exterior of Industrial Buildings. Special Decorative Effects. Interiors of Buildings. Bond of Applied Coatings.

Report of Committee C 4 on Metal Forms. Edward A. Steele, chairman.

Paper on Repair of Concrete Ships.

Paper: Graphic Determination of Stresses. Prof. George E. Beggs.

B.C. ENGINEERS WORK ON AFRICAN PROJECT

THE first party of engineers which went from British Columbia to take charge of harbor and railway construction work on behalf of the Imperial Government on the Gold Coast, West Coast of Africa, has arrived at the scene of operations. The contract for the work was secured by the contracting firm of General J. W. Stewart, C.B., K.C., M.G., of Vancouver, the well-known railway builder. The cost of the work will ultimately total over eleven million dollars.

Major C. R. Chrystdale, A. G. Graham, Angus Stewart and Major John Retallack, all well known in Vancouver and Victoria, comprise the party. Major Retallack is not connected with the Stewart enterprise, but has gone out to take up an appointment under the Colonial office. Another large party of engineers will leave London shortly, among them being two or three British Columbia men and many other Canadians.

The preliminary work on the big contract is understood to be proceeding well and actual construction will be under way shortly. Before the harbor works could be commenced it was necessary to lay out a townsite and set up a modern village for the white workers. Construction of the railway cannot proceed very rapidly until the harbor work is well in hand.

J. W. Shackleton, civil engineer of Chatham, Ont., is constructing a new map of the city, together with all the latest additions, and will incorporate in it details of the survey of the city when it was first marked by the government over 100 years ago.

THE IMPORTANCE OF IRRIGATION WORK

Benefits Achieved in Alberta Are Encouragement to Further Expenditures

A. S. Dawson, M.E.I.C.

Chief Engineer, Department Natural Resources, Canadian Pacific Railway Company, Calgary

ACCORDING to an article in "The Monetary Times Annual" for 1922, by Mr. A. S. Dawson, up to the end of 1920 there had been expended on the construction or irrigation works in Southern Alberta about \$20,000,000, to serve about 850,000 acres of irrigable land.

This phase of development was practically all handled by large companies — pre-eminently the Canadian Pacific Railway Co., who held large blocks of vacant land, constructed the works to serve them with water, and then sold to new settlers, with a perpetual contract for a supply of water to the lands at a fixed annual charge. This form of enterprise has developed all the large projects constructed up to date. The conditions gradually changed, because the large areas that still awaited development were practically all settled, and plans were formulated to develop these areas by co-operative effort on the part of the land owners themselves.

Federal Government's Work

In Canada, the Federal Government controls all the water, conducts the hydrometric work, and makes all preliminary surveys and investigations in connection with irrigation development. No works can be undertaken without government sanction, based on thorough engineering investigations which have proven the feasibility and economic soundness of all schemes of any magnitude.

These surveys to date show that close to a million additional acres in Southern Alberta can be served with water within reasonable cost limits; and some of this area will probably be served as a result of the recent settlement of certain long outstanding matters between Canada and the United States, and within the scope of the International Waterways Commission. Preliminary surveys also indicate that additional areas of about 3 million acres in Alberta, and $4\frac{1}{2}$ million acres in the Province of Saskatchewan could also be profitably irrigated.

Value Demonstrated

During the past dry cycle of five years, all doubts as to the benefits of farming large portions of Southern Alberta under irrigation methods have entirely disappeared, and now everyone is an enthusiast of the idea of bringing every possible acre under the ditch system.

But how were the construction charges to be met? The settlers were not financially able to, as a result of several short crops; and there was no incentive for corporate interests to provide the necessary capital. The Provincial Legislature therefore decided — or rather were forced — to provide the necessary machinery, whereby these systems can be built by means of the enactment of what is known as the "Irrigation District Act." This act provides for the formation of irrigation districts, with power to raise the necessary funds to construct the works by bond issues, the security for which is the land within the district.

Among the outstanding features of this act are the appointment by the Lieutenant-Governor of an "Irrigation Council," who may forbid any act or course of conduct proposed to be done, or entered upon by the board of directors; and without whose authority no expenditure can be made on any debenture issue, nor any contracts for construction awarded. All debentures issued under the act must provide for the payment of the whole principal money within 30 years of the date of the issue thereof, and shall be repayable by annual instalments extended over the whole of such period, or not less than the last 20 years thereof. The sale of debentures and rates of interest are subject to the approval of the government. Moreover, the province has undertaken to make a full guarantee of these bond issues, together with the interest. As previously stated, the Dominion Reclamation Service makes all preliminary surveys and in-

vestigations as to the feasibility of a project. When these are completed, and the boundaries of an irrigation area are fixed, the act provides that a petition signed by the owners of at least 51 per cent. of the area involved shall be submitted to the Minister of Public Works of the province, asking for the creation of the district. After approval of such, a board of three trustees is elected to conduct its affairs.

Financing Irrigation

The first district to be financed under this procedure is what is known as the "Lethbridge Northern," containing an irrigation area of about 105,000 acres, which is now well under construction, at an estimated cost of \$51.00 per acre. The total bond issue authorized for this project was \$5,400,000, and of this, \$4,400,000 worth of 30 year bonds were disposed of at a very favorable rate. Provision was made for making the bond issue large enough to carry interest, and operation and maintenance charges until the end of the year, after the completion of the works — so that the farmers will get the benefit of the water before they have anything to pay. In the case of the Lethbridge Northern project, no payments toward a sinking fund are required to be made until after the seventh year.

Construction has also been commenced on another district known as the "United," containing 23,000 acres irrigable, at an estimated cost of \$645,000, or \$28.00 per acre. Several other districts are in the course of formation; and the government of the province has announced as a definite policy that it will guarantee the bond issue for any project which has been shown to be feasible, and economically sound by means of thorough surveys and investigations on the part of the Dominion and provincial engineers.

This policy will no doubt have a very marked effect on irrigation development in Southern Alberta. There are, however, many problems which will result therefrom, such as the reductions in size of the holdings, and the colonization of the additional farm units created.

Survey Board Created

Another matter which may be of interest to many is, that this government (and a Farmers Government at that) has recently created what is known as the Southern Alberta Survey Board, consisting of 4 outstanding men, and including as chairman, the chairman of the Canadian Section of the International Waterways Commission. This board held their opening session on November 29th last, and are now sitting, and their obligations are to "Enquire into, report on, and make recommendations, in regard to the undertaken matters affecting the welfare of those areas in the southern part of the province which are subject from time to time to drought.

"(A)—A policy in regard to the development of farm lands, which surveys of the Dominion Reclamation Service show the possibility of irrigating.

"(B)—Methods that may be adopted in furtherance of the colonization of irrigable lands.

"(C)—A policy in regard to the furtherance of the greater economic advantage of farmers on land which cannot be irrigated.

"(D)—The expediting of the investigations by soil and topographical surveys already initiated.

"(E)—The general financial conditions prevailing in the areas referred to, having regard to the prime necessity for the maintenance of credit of individuals, institutions and municipal and school districts."

It is needless to point out the problems to be dealt with by the board are very great, and upon their solution the future welfare of a very large portion of the people of the province depends.

Educational Work

In addition to two experimental and demonstration farms maintained by the Federal Government in Alberta, the Provincial University is doing splendid work, and now has a three-year course in agriculture leading up to the degree of P.S.A., in addition to a combined six-year course in arts and agriculture.

The Provincial Government Department of Agriculture also operates 5 agricultural schools, and 5 demonstration farms, on two of which instruction is given on all matters pertaining to irrigation.

What is needed is co-operation and team play between the men on the land and those who are endeavoring to work out the broader questions affecting irrigation development on a large scale; and in such work, organizations such as the Western Canada Irrigation Association, and the recently created Survey Board of Southern Alberta, have a large part to play, and should prove a powerful factor in the general welfare of the province.

Agriculture and live stock business are the basic industries of this portion of the country, and must go hand in hand. Irrigation stabilizes both, and therefore stabilizes business conditions in general.

AMERICAN GOOD ROADS CONVENTION

IN order to bring about closer co-operation and a more thorough exchange of views and experiences in building highways, especially along the border between the two countries, Canadian road and street officials, engineers and contractors to the number of several thousand, are being invited to participate as delegates in the 12th American Good Roads Congress and 13th National Good Roads Show, to be held in the Coliseum, Chicago, January 17 to 20. The big convention, which this year will assume more of an international character, will be held under the auspices of the American Road Builders' Association.

Among the new officers recently elected by this organization is W. A. McLean, deputy minister of highways, province of Ontario, who was chosen a director. Prominent in the work of the organization also are: J. A. Duschatel, city manager of Outremont; Lucius E. Allen, Belleville, Ont.; Malcolm Calder, Calgary, Alta.; H. J. Walker, Cornwall, Ont.; F. M. Clark, Halifax, N.S.; H. A. Brazier, London, Ont.; C. C. Lapierre, Paul Emile Mercer, John Randall Roberts and H. C. Van Scoyoc, Montreal, Que.; C. R. Wheelock, Orangeville, Ont.; John C. Dufresne, Penticton, B.C.; Henry Gabriel, chief engineer, department of highways, province of Ontario; B. Michaud, deputy minister, department of roads, Quebec; F. C. Biggs, minister of public work, province of Ontario; R. C. Harris, commissioner of works, Toronto; K. D. McDonald and George William Rayner, all of Toronto; S. L. Squire, president Canadian Good Roads Association; Walter Scott, Victoria, B.C., and many other Canadians active in highway work.

That Canada will be well represented at the congress is evidenced by the fact that governors of Canadian provinces, mayors of Canadian cities, and Canadian good roads, engineering and contracting organizations are expected to send from three to five official delegates each to participate in the discussions and report as to the latest developments in road and street construction demonstrated and explained, during the meeting.

Canada's Programme

The great programme of highway construction upon which Canada is embarking will be fully discussed along with prospects for 1922, highway finance, administration, maintenance and transportation, highway accidents and their cause, fall contract letting, bridge construction, drainage, salvaging old roads, highway specifications, material prices and labor, traffic regulation, training engineers and supervisors and other subjects too numerous to mention. The congress and show will surpass anything of the kind ever held, either in Europe or America, both in point of attendance and instructive value and in the number and variety of the exhibits of road-building machinery, materials, methods and appliances and highway transportation equipment. Fully 20,000 delegates are expected to attend, not only from the United States and Canada, but from Cuba, Porto Rico, Hawaii, Alaska, Mexico and several South American countries. All of the 40,000 square feet of exhibiting space in the Coliseum and annex was taken at the first drawing of space in October, making it necessary

for the exposition officials to lease adjoining buildings in order to house the overflow. The United States Bureau of Public Roads will have an enormous exhibit, covering 2,000 square feet, and demonstrating impact, material and sub-grade tests and the methods of construction approved by the government.

Will Discuss Materials

One session of the congress will be devoted to Portland cement concrete roads, another to the asphalt and bituminous types, a third to brick and other types of pavement, and fourth to earth, gravel and macadam roads. Another session is to be given over to a thorough discussion of the problems involved in highway transport. The Portland Cement Association, The Asphalt Association, The National Association of Paving Brick Manufacturers, and other organizations are co-operating with the American Road Builders' Association in organizing the congress.

LARGE FEDERAL LOAN FOR HIGHWAYS

WITH the exception of Alberta, all the provinces of the Dominion have taken advantage of the Federal aid to highways plan, and highways department officials feel that the appropriation of \$20,000,000, which the Federal Government set aside in 1919 to be apportioned on a forty per cent. basis, will be used up before the end of the five-year period covered by the appropriation.

The estimated cost of highway improvement projects undertaken to January 1, 1922, under agreement with the Federal Department, was \$29,247,667, with a total mileage of approximately 4,370 miles. The Dominion Government's share of the projects under agreement is \$11,699,066, and the act has yet almost three years to run.

It is expected that before the expiration of the appropriation there will be requests from the various organizations interested in highway building and improvement for increases in the Federal grant for the purpose.

Saskatchewan leads the provinces in respect to the mileage of projects under agreement, with 1,230 miles, at an estimated cost of \$1,375,093, and an average cost per mile of \$1,124.

Ontario is well in the lead in cost of roads built, however. The figures for this province are: Projects, 23; mileage, approximately, 603; estimated cost, \$13,863,155; average cost per mile, \$22,980.

Figures for the other provinces are:

Alberta, none.

British Columbia, mileage, 337; estimated cost, \$2,612,693; average cost, per mile, \$7,731.

Manitoba, mileage, 764; estimated cost, \$3,478,902; average cost, per mile, \$4,546.

New Brunswick, mileage, 1,200; estimated cost, \$3,058,708; average cost, per mile, \$2,571.

Nova Scotia, mileage, 168; estimated cost, \$1,790,325; average cost, per mile, \$10,605.

Prince Edward Island, mileage, 181; estimated cost, \$329,565; average cost, per mile, \$1,818.

Quebec, mileage, 243; estimated cost, \$2,712,226; average cost, per mile, \$11,116.

The total number of projects under agreement is 170, with an average, per province, of 21, and the average cost, per mile, of all the roads constructed under agreement is \$6,182. Highway plans must be approved by Federal officials before payment of the 40 per cent. cost is allowed.

The Wellman-Seaver-Morgan Co., of Cleveland, Ohio, has been awarded a contract for thirty-four cargo handling cranes for the Department of Docks for the city of New York. This order constitutes the largest installation of dock cranes ever placed on this side of the Atlantic. The cranes will all be of the semi-portal gantry type, with travelling, revolving, hoisting and boom-lifting motions. Twenty-six of them will have a capacity of from 2½ tons to 5 tons while eight will have a capacity of from 1½ ton to 2½ tons.

ENGINEERING INSTITUTE TO HOLD GENERAL MEETING

THE Annual General Meeting of the Engineering Institute of Canada with which will be associated a Professional Meeting, under the auspices of the Montreal Branch, will be held at Montreal, January 24-25. A number of important committee meetings will take place about this time. The following program has been arranged.

Tuesday, Jan. 24

- 9:00 a.m. — Registration, E.I.C. Headquarters, 176 Mansfield St.
- 10:00 a.m. — Annual Meeting Called to Order.
- 1:00 p.m. — Informal Luncheon. (Tickets, \$1.00.) C.P.R. Windsor Street, Mezzanine Dining Room.
- 2:30 p.m. — Resumption of Business Meeting and President's Address.
- 7:30 p.m. — Banquet, followed by Smoking Concert. (Tickets, \$5.00.) Rose Room, Windsor Hotel.

Wednesday, Jan. 25

- 10:00 a.m. — Visit to Dominion Engineering Works, Rockfield. (Large 41,000 h.p. turbine unit for Shawinigan may be seen under construction.)
- 1:00 p.m. — Luncheon — Rose Room, Windsor Hotel. Members and Ladies. (Tickets, \$1.50 — Visiting Members, Complimentary.) Followed by short address.
- 3:30 p.m. — Professional Paper at Headquarters.
- 8:15 p.m. — Professional Paper at Headquarters.

The Montreal Branch extends a cordial invitation to all members of the Institute and desires it to be known that accommodation for visiting members will be reserved at the Windsor Hotel. Further information may be obtained from J. L. Busfield, secretary-treasurer, Montreal Branch E.I.C., 260 St. James Street, Montreal.

HYDRO CONGRATULATED BY DISTINGUISHED ENGINEER

AFTER witnessing the formal opening of the Queenston-Chippawa power development on December 28, Francis Lee Stuart, consulting engineer, New York, wrote to Sir Adam Beck a warm letter of appreciation of what the Hydro-Electric Power Commission of Ontario had accomplished. Mr. Stuart, who formerly was chief engineer of the Erie and the Baltimore and Ohio Railroads, is now, incidentally, vice-chairman of the Technical Advisory Board of the Port of New York Authorities, and consulting engineer of the Hudson River Bridge Corporation, in charge of all foundation work and terminal facilities, a project involving an estimated expenditure of \$550,000,000. The letter reads as follows:

"You are today formally opening an undertaking which is of epoch-making importance and far-reaching in potentialities for the material progress of Canada, as well as of the Niagara district of Ontario.

The vision, will and ability of the Commission and the people of the Niagara district to develop their natural resources to such an efficient degree will be appreciated more and more as the years go by.

The conception is simple — the water is taken by an open canal from a point at the head of the rapids above the Niagara Falls and delivered to a powerhouse at the foot of the rapids below the Whirlpool — thereby getting all of the energy possible from each cubic foot of water used in its passage from Lake Erie to Lake Ontario.

The magnitude and importance of the work in carrying out such a conception is one of the accomplished feats of our generation. It is the largest single Hydro-Electric development in the world and is the largest publicly owned undertaking of its kind ever attempted. It is a path-finder in such a field.

Its importance is not yet fully understood. By the magnitude of the cheap power produced and by the example of its usefulness it will directly and indirectly give an im-

pulse to the upbuilding of the entire country, which will be second in importance only to the effects which the railroads have had on the country's growth. The difficulties of construction were many and at times seemingly insurmountable. Each foot of canal represented effort, each mile great difficulties overcome, and each section of the work an established precedent in construction.

The personnel who carried out the work were faithful, hard-working, able engineers and superintendents of construction, meeting their problems daily with a resourcefulness, courage, and earnest effort which deserves your admiration. Gaby, Acres, Angell, Goodwin, Brandon, Hogg, Hull, Hearn, Millar, Blanchard, Scriven, LeRoy, Anderson, Reid, Nablo and many others should be remembered as men who carry on, and carry on well.

It should be a matter of congratulation and of gratitude to the directing force of and of those on the work that this great project has been carried through in such a workman-like way with honest and able men, without discord, disaster, or scandal and now, without fuss or feathers, stands out as an accomplished fact, a splendidly effective addition to your resources of which all Canada can be proud."

PORTLAND CEMENT ASSOCIATION

AN important step towards ensuring high and uniform quality cement was taken recently by the Portland Cement Association at the final session of the annual meeting held in New York recently, when the Association's constitution and by-laws were amended so as to make membership in the Association "contingent upon member's product meeting the standard specifications for Portland cement adopted by the United States Government and the American Society for Testing Materials."

Engineers, architects and contractors are familiar with the high standard of specifications governing cement manufacture and will herald this action as the greatest advance step ever taken by the industry. The Portland Cement Association is distinguished for its co-operative work with technical societies. This has been in the nature of contributing to the improvement of building materials, methods and standards in general, among these being building codes, but the Association has particularly been active in keeping standard requirements for Portland cement on a high plane and in insuring its proper use by the consuming public.

HYDRO RADIAL BY-LAWS PASSED

AN interesting feature of the recent municipal elections in Ontario was the passing of the Hydro Radial by-laws. A by-law was passed favoring the purchase of the Niagara, St. Catharines and Toronto Railway. In this case practically all the municipalities gave large majorities in favor of the purchase while the Toronto Suburban and the Toronto Eastern Railway by-laws were also passed by substantial majorities.

What is admitted by experts to be an ideal interurban traction project has been endorsed by the electorate on behalf of public ownership. Five lines radiating from Toronto connecting with Guelph and the Niagara frontier will give a balanced load factor which is a condition precedent to the successful exploitation of any interurban rapid transit system. When the vote is implemented by legislation Sir Adam Beck will be able to deal at once with the Toronto terminal situation, the power and radial "clean-up" can be consummated, the various lines co-ordinated into one system and, with betterments brought up to a proper standard or roadbed and equipment.

In the United States there are 7,338 firms manufacturing trucks, tractors, automobiles and other vehicles dependent upon good roads and having a total invested amounting to \$6,000,000, an amount exceeding one-third the capital of the country's railroads and an annual output of 1,500,000 passenger cars valued at \$1,410,000,000; 300,000 commercial cars valued at \$400,000,000 and 165,000 tractors valued at \$225,000,000.

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TRAFFIC INCREASE AND GROWTH OF POPULATION

IN any estimates of future traffic made for the purpose of planning transportation facilities or public utilities associated with transportation, the first ideas of the engineer are likely to gather about the rate of growth of population. It is perhaps natural to assume that if the population of a community doubles, the traffic by rail or by highway would at the same time be doubled. That the true law of increase of traffic differs widely from this may be shown conclusively by the consideration of some typical cases.

Consider, for example, the growth of steam and electric railway traffic in Canada and in the United States in recent years. Whereas in Canada the passenger traffic on steam railways increased from 1901 to 1919 by 138%, the freight traffic increased during the same period by 216%, and the passenger traffic on electric railways increased 520%, the population increased only 65%. In the United States the increase in passenger-miles for the same period was 189% and in freight ton-miles it was 158%, while the population increased only 38%.

If traffic within a large city or between two cities be considered, a similar law is seen to hold. From 1912 to 1919 the increase in vehicular traffic across the East River bridges at New York increased 153%, whereas the population of Greater New York increased but 12%. Between Philadelphia and Camden, N.J., the passenger ferry traffic across the Delaware River between 1900 and 1920 increased 176%, the vehicles carried by the ferries increased in number by 153%, while the population increased only 41%. Between the years 1912 and 1920, the trans-bay passenger traffic between San Francisco and the cities opposite, including Oakland, Berkeley and Alameda increased 35% in spite of the discouragement offered through the 8-mile ferry and electric railway trip between San Francisco and Oak-

land. During these eight years the population of San Francisco increased but 17%.

It thus appears that traffic either by rail, by highway or by ferry within a large community, or between communities, increases far more rapidly than the population. The basis of such a law is not difficult to find. Within recent years, the means of transportation have enormously multiplied and improved. Although very considerable extension of steam and electric railways has occurred in America during the past twenty years, a most astounding increase in motor transport facilities has occurred during the same period. In the United States the production of motor vehicles increased from 1910 to 1920 by 1080%, while at the same time the population increased but 15%. In Canada the motor vehicle registrations increased from 1910 to 1920 by 4400%, corresponding with an increase in population of 27%. Registration of motor vehicles in Ontario for the same decade increased 3600%, while at the same time the population increased 16%.

With the extension of the facilities offered for travel, particularly by the enormously increasing production of motor vehicles, it is natural that highway traffic should have increased on the better class of roads at an enormous rate. An interesting statement made recently by a prominent engineer of the State of Michigan indicates that with the improvement of the highway between Ypsilanti and Ann Arbor, the vehicular traffic increased from 240 vehicles per day six or seven years ago to 3,100 vehicles a day during the last year. It is probable that this is merely typical of the experience of other improved highways. Figures of like order might be quoted to show the amazing increase in traffic on the Toronto-Hamilton highway following its improvement during the war period.

Estimates of traffic over a given route can, therefore, be made safely only after considering along with the probable increase in population, the probable effect of the added facilities for transportation. Their is such a thing as a habit or fashion in movement of traffic, as there is in less serious matters. Once the public gets accustomed to an improved highway, for example, and finds the service or facility offered to be an attractive one, traffic is bound to increase at an astounding rate, as has been the experience in recent years where new and popular facilities for transit have been provided.

THE ENGINEER AS A MANAGER

FRANK discussion of the shortcomings of the engineer as an executive or administrator was brought out following the address of R. C. Harris, Commissioner of Works, Toronto, at the Toronto meeting of the American Association for the Advancement of Science. The engineer should make the highest type of administrator, said Mr. Harris, but by reason of native modesty or unsuitable training, he frequently fails to appreciate the economic features of the situation, and discloses inability to relate the creation of physical works to the value of the dollar. He has not generally had sufficient human contacts to make him a good executive, and, continued Mr. Harris, regards himself rather more as a builder or constructor than as a manager of men.

The qualifications of the engineer as a manager have been vigorously debated in the engineering press during the last few months, growing out of an address by Philip Cabot, member of a prominent New York financial house, at a joint meeting of the Founder Societies in New York last October. Mr. Cabot's strictures were severe. He characterized the engineer as scientific, studious, severe, ascetic, cool, cautious and unimaginative. "He is a man," said Mr. Cabot, "who curbs his enthusiasms, who does not allow his conclusions to be colored or influenced in the slightest by an idealistic or impulsive temper." According to Mr. Cabot, these characteristics render the engineer constitutionally unfit to lead or direct large industrial or public enterprises. He pictured the successful industrial leader as one having the capacity to inspire large bodies of men, and as the possessor of the promoter or salesman type of mind rather than that of the student or scientific investigator.

He regarded the engineer as a hand which executes rather than a mind which directs and controls, and believed him to be an unpromising candidate for promotion to managerial positions.

Those who have risen to the defence of the engineer in these discussions have pointed out that while the promotional type of mind is useful, it is an exceedingly dangerous one unless carefully watched and guided. The enthusiast who sees everything in a rosy light is likely to wreck an enterprise much more quickly than the cool and unemotional engineer. It very frequently happens that the latter is called in to straighten out some of the financial and operating muddles that have been brought about by a manager of the promotional type.

The truth of the matter is that the management of industrial or other enterprises that involve dealing with a large force requires several characteristics or qualities of mind. Enthusiasm must be matched by cool and careful judgment. Wherever a man can be found who combines in himself the capacity to direct and inspire large bodies of men with sound technical and financial knowledge, his price is above rubies. Men of this type who have undertaken managerial work are not unknown. On this continent, two notable examples in recent years are General Goethals and Herbert Hoover, not to mention several of our fellow-Canadians who are successfully directing large undertakings at the present time. It will be interesting to survey the field in ten or twenty years and discover the effect of the increasing popularity of courses in administrative engineering. Once the idea of the suitability of the administrative field for graduate engineers has been thoroughly assimilated, and engineering students have been taught to appreciate the financial and managerial factors in an enterprise, as well as the technical ones, the number of engineers in managerial positions should increase very rapidly.

Already very considerable numbers of engineers are known to be occupying executive positions on this continent. At least six railroad presidents and five vice-presidents are engineers. Of the 230 city managers in Canada and the United States, about 75% are civil engineers. Municipal councils appreciating the fact that the largest item of the civic budget is associated with the department of works, naturally look to the civil engineer as likely material for a city manager. As long as it is possible to discover men who have not only sound technical knowledge, but courage, executive and business capacity, a knowledge of municipal law and finance, and ability to explain clearly and precisely the civic policy to the citizens, city managerships should prove a likely field for the engineer. With the growing tendency for this form of civic government it is very probable that the engineer will be more and more frequently employed in public administrative posts.

AN ENGINEER'S TRIBUTE TO HYDRO

THERE is danger of political controversy obscuring in some measure the solid engineering achievement involved in bringing the Queenston-Chippawa power development to the production stage. Those who are in a position to appreciate the difficulties—engineering and economic—overcome in this work cannot fail to rank it with some of the greatest enterprises in the history of engineering. In other days, men who did less than the directing heads of the "Hydro" engineering staff were accorded national, and even international, honours. It is refreshing, in the midst of present calumnies, to read elsewhere in this issue the hearty tribute of Francis Lee Stuart, an engineer peculiarly qualified to express an opinion on the worth of the services of other engineers.

OBITUARY

ADAM BEATTIE, construction engineer, who was associated with the Grasseill Chemical Co., of Magog, Quebec, for over 23 years, died recently in the Homeopathic hospital, Montreal. Mr. Beattie was born in Owen Sound, Ont., 67 years ago.

PERSONALS

PROF. J. P. McMURRICH of the Department of Anatomy University of Toronto has been elected President



of the American Association for the Advancement of Science for the coming year and will preside at the next Convention of the Association which meets at Boston, Mass., December 26th, 1922. Prof. McMurrich graduated from the University of Toronto in 1879 and two years later obtained his degree of Master of Arts. Four years later he secured his Ph. D. from the John Hopkins University at Baltimore. The degree of L. L.D. was conferred upon him by

Michigan University in 1912. From 1882 to 1884 he was Professor of Biology at the Ontario Agricultural College. He then went to the United States where he occupied several chairs in anatomy and biography at various colleges, returning to Toronto from Ann Harbor, Michigan.

PROF. F. R. MOULTON, of the University of Toronto, has been elected secretary of the Chemistry section of the American Association for the Advancement of Science.

A. ST. C. RILEY, formerly general sales manager of the Trussed Concrete Steel Co. of Canada, Ltd., has been appointed manager of the Montreal Branch of that company with offices in the Drummond Building, 511 St. Catharines St. W., Montreal.

RECENT PUBLICATIONS

STANDARD SPECIFICATION FOR WIRE ROPE. The Canadian Engineering Standards Association has issued a new bulletin No. 4, 1921, containing the standard general specification of wire rope. The specification which embodies those requirements for standard grades of wire rope for mining, dredging and similar purposes, which are regarded as essential in order to protect the purchaser against an inferior or defective product, and to guide the manufacturer or importer as to standard practice in Canada. It will be observed that the specifications are combined. This was done because it was recognized that the governing conditions for both kinds of work were so far in agreement that separate specifications were unnecessary. Copies of this specification may be obtained from R. J. Durley, secretary of the Canadian Standards Association, Ottawa.

The personnel of the Southern Alberta Railway Board consists of C. A. McGrath, Chairman, Judge A. A. Carpenter of the Public Utilities Commission of Alberta, G. R. Marnoch and W. H. Fairfield of Lethbridge. The purposes of the board are to recommend a definite irrigation policy based on the report of the Dominion reclamation service; soil surveys and classification of non-irrigable areas, with recommendations as to possible farming methods or other uses; the making of individual farm surveys, with a view to inquiring into the financial conditions of farmers in the dry areas. Lethbridge will be the headquarters of the commission.

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

St. Lawrence Navigation and Power Investigation

Details of Double Development Plan as Proposed by the New York & Ontario Power Co. — Suggestions Based on 14 Years' Study of Conditions in Vicinity of Waddington — Proposed Sites at Rapid du Plat and Long Sault

THE suggestions offered herein are based upon the experience and studies continuously carried on by the New York & Ontario Power Co. during the past fourteen years. During this period an engineering office has been maintained in this division and three different hydro-electric power plants have been operated at various times. Particular attention has been given to the section between the Long Sault Rapids and Ogdensburg on account of the possible extension of the company's development at Waddington, N.Y.

General Description of River

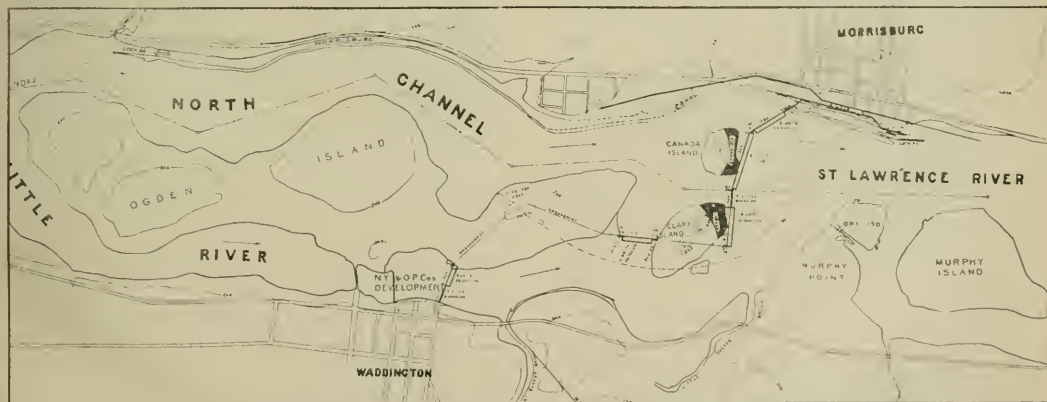
Having regard to the various problems involved, and to the governing physical conditions existing, the following description of the river is given preliminary to a more particular consideration of the method of development.

The discharge of Lake Ontario is now controlled by the

ance being made for the necessary slope between these points.

From Morrisburg (Lock 23) to the head of the Long Sault Rapids (Lock 21), the fall is 12 ft. in a distance of 16 miles, the shores being generally much lower than those above (or west of) Morrisburg.

From the head of the Long Sault Rapids to the foot of Barnhart Island (5 miles), the fall is 41 ft. and the shores are correspondingly lower than those above Lock 21. By constructing a low dam in the vicinity of the foot of the Long Sault Rapids the greater part of the present fall between Morrisburg (Lock 23) and the foot of Barnhart Island (53 ft.) is recovered for navigation and power purposes without serious flooding, raising the proposed pool dangerously, or causing very serious interference with any development near Morrisburg at the foot of the Rapid du Plat.



GENERAL LAYOUT OF WADDINGTON—MORRISBURG SITE. NEW YORK AND ONTARIO POWER CO.

channels through the Galop Rapids. The cross-section of the river between Kingston, Ont., and Ogdensburg, N.Y., is so great that there is less than 1 ft. fall in the intervening 60 miles, consequently the Lake Ontario level is continued practically to Ogdensburg.

Between Ogdensburg and the head of the Galop Rapids (5 miles) the fall is less than 2 ft., and from the head of the Galop Rapids (Lock 27) to Morrisburg, Ont., (Lock 23), the fall is 13 ft. in 16 miles, the total fall from Ogdensburg to Morrisburg being, therefore, 33 ft.

The shores from Ogdensburg to Morrisburg are moderately high and except at Iroquois, no serious flooding would result from carrying the Ogdensburg level down to a dam at the foot of the Rapid du Plat (Morrisburg), due allow-

From the easterly end of Barnhart Island to Cornwall (Lock 15) the fall is 6 ft. and the shores are lower. It is not considered practicable to dam the river between these points.

The river bed is mostly boulders underlaid with hard clay mixed with stones, beneath which is hard limestone rock at a more or less varying elevation. Drilling has been done at different points to determine the surface elevation of the solid rock, and the results are available.

There is every indication that the St. Lawrence River has cut its present channel largely through the agency of ice, in fact the process is still going on and may be witnessed at some point or other between Montreal and Ogdensburg during any severe winter. In bays and quiet spots the ice occasionally attains a thickness of about 36 inches

by direct freezing, though it is frequently many feet in thickness on account of frazil and anchor ice being forced beneath the field ice and firmly adhering thereto. Where the water is in movement ice forms more slowly, though so many factors are involved in ice formation that it is difficult to predict what ice will do, except under known conditions of flow and after long continued observation.

One point to be remembered is that the St. Lawrence flows in a generally north-easterly direction and the canal records disclose that commencing at Lock 27, the farther down stream you go the earlier does ice formation occur in the winter and the later does it break up in the spring.

It is the intention to discuss herein only those points in the engineers report which do not conform to this company's plan of double development described hereafter, or which affect the costs when making comparison with the single development scheme given in the report.

Regulation of Lake Ontario

In any plan for the improvement of the River St. Lawrence the regulation of Lake Ontario is a most desirable feature, and, to the extent that it is practicable, should receive first consideration from both the standpoint of navigation and power. (See Appendix A).

General Plan of Double Development

Consideration of the foregoing description of the river, its ice condition, etc., makes evident that two sites are best adapted for navigation and power works.

The first is at the foot of the Rapid du Plat, near Lock 23, and the second is at the Long Sault Rapids. The Rapid du Plat dam would control the river between that point and Ogdensburg, thereby regulating the surface elevation of Lake Ontario and the discharge therefrom.

In any case, the improvement of river channels for navigation above the Rapid du Plat Site, and the consequent flooding damages are assumed to be the same, as the same pool elevations would be used. The comparative merits of the alternative methods of development therefore depend upon the various factors entering into the subject east of Leishman's Point.

The project herein outlined has the following advantages:

1. It controls the outflow of Lake Ontario.
2. It avoids flooding practically any of the thriving and thickly settled rural communities east of Morrisburg.
3. It provides a deep waterway channel at an early date throughout the whole division.
4. It develops more primary horsepower than any other method, and furnishes over 600,000 h.p. within a short period, to satisfy the present demand for power.
5. It preserves the water front on both sides of the river between Lock 23 and the Long Sault for the location of industries.
6. Provides best and safest conditions for winter operation.
7. Provides a site for both American and Canadian Locks.

In a general way the project would include power houses at Barnhart Island, and the dams necessary to raise the water level to approximately elevation 210, and a second power house combined with structures suitable for the control of Lake Ontario at Morrisburg. Navigation at the lower site will be provided with a canal having a lock at its lower end and guard lock at upper end. At the upper (or Morrisburg) site provision is made for navigation through a canal on the Canadian side with a lock. There is also a practicable lock site on the American side of the river.

All structures would be designed for a definite elevation of water surface, and whatever property is damaged in the flooded area would be acquired at the outset.

The work would be carried out in two stages. The first stage would include all structures at the Morrisburg site. The second stage would include the work at the Long Sault.

It might be impossible, but in any event it would be difficult to construct dams and power houses at the Long

Sault until the discharge of the river in winter is under effective control from regulating works at Morrisburg.

(See Engineers Report on ice conditions with elevation of water surface of Long Sault Rapids in 1918).

If it is found expedient to provide for 20 or 25 ft. navigation through the division before the second stage is completed, then additional excavation might be required in the prism of the Cornwall Ship Canal, and jetties built in the river to raise the elevations of the water surface at the entrance to the canal to some elevation higher than at present.

Structures at the Long Sault Rapids and Barnhart Island

Accepting the general layout submitted in the Engineers Report as applying as far as possible to the double development, the following changes would be required:

(1) The north end of the Barnhart Island power house would be tied into the Cornwall Ship Canal by a short and substantial concrete dam. This eliminates the long dykes and embankments necessary in the single development to tie the power house and canal structures into the high ground on Sheik's Island, and from there into the Canadian main land north of Moulinette.

(2) The crest of the spillway is reduced from El. 1,231 to El. 210, and designed to withstand the pressure from a stage of El. 217 in place of El. 246. All retaining walls and abutments having copings at El. 217 in place of El. 238.

(3) Ice diversion works have curtain wall top reduced in El. from 245 to 217. Power house structures reduced from El. 245 to 217, and designed to withstand 29 ft. less head.

(4) Elimination of all embankments and dykes between El. 243 and 222. Practically all core walls are eliminated.

(5) Hoople's Creek diversion is eliminated.

(6) All embankments and dykes on the Canadian and American main shores are eliminated.

(7) Massena Power House and other works in connection therewith are eliminated. The existing Massena plant of the Aluminum Co. of America would be practically undisturbed.

(8) The length of the Power House would be approximately the same as in the single development, but the construction would be much lighter due to the design being for 29 ft. less head and the decreased weights in machinery.

Similarly for the Cornwall Ship Canal the proposed general layout would be changed as follows:

(1) Lock 7 would be in the same position.

(2) Lock 8 at Moulinette would be eliminated.

(3) Guard locks would be required, but would be moved down stream near site of proposed Lock 8 in the Engineers Report or farther east if necessary.

(4) Canal bank on north side carried to El. 222 as far east as the Guard Lock. Drainage led to Culvert under canal as in the Welland Ship Canal.

(5) Water level in the Cornwall Ship Canal to be El. 210 in place of El. 200, and banks made to correspond.

(6) The approach channel would be required to be extended farther upstream. But this would probably be advisable in any event.

(7) The portion of the Cornwall Canal known as Bargan Lake would be utilized as a supply channel to the power houses, thus relieving the Little River Channel (between Sheik's and Barnhart's Islands).

Structures at Morrisburg and Ogden Island

Since the double development project would require power houses at Morrisburg combined with regulating works and navigation facilities, the layout as given in the Engineers Report would have to be considerably changed.

The channels at and below Ogden Island provide a means of building a large portion of the structures in quiet work. The rock is at a satisfactory elevation.

The large area that may be conveniently unwatered or at least rendered quiet for construction purposes allows various layouts to be made.

The protection that would be afforded by the Islands, and the utilization of the intervening channels during the

winter season for the purposes of both construction and operation offer great advantages to a location in the vicinity of these islands.

It is proposed to submit herein merely a tentative layout for the works, but the following items show that this location is best suited for economical power development in connection with facilities for regulation and navigation.

(1) A large area is available for power houses, spillways and other structures.

(2) Material can be brought by water to the site for a large percentage of the construction work.

(3) Navigation during construction period is taken care of.

(4) Protection from ice during construction is assured.

(5) Sites are available on both sides of the river for locks.

(6) Successful operation of power houses in winter season is assured by the protection afforded by islands, with more than one large channel leading to one forebay and the independent operation of Little River which may be utilized as a relief channel in case of ice congestion in the main channel.

(7) The velocity in main channel a short distance from structures will aid in keeping them free from ice troubles.

(8) Open water during the winter below the structures will tend to prevent ice jams. Winter backwater effects on the plant would be negligible.

(9) The structures required for purely regulating purposes will be less extensive than in the single development. The power house itself affords a large measure of regulation, and the greatly increased head on the sluices gives them an increased carrying capacity.

(10) The risks and uncertainties in prosecuting the work at the Morrisburg site are much less formidable than those in connection with a high head plant at the Long Sault, and contractors would not require to make such large allowances for contingencies.

River Improvement Between Morrisburg and Long Sault

It will be necessary to make some river improvements between Morrisburg and the Long Sault for navigation. This is mainly necessary in order to reduce the velocity, and is relatively not a serious matter. The regulation of Lake Ontario as outlined in appendix A will reduce the maximum velocity that can occur, and hence reduce the amount of excavation below that which would otherwise be required under the method of regulation, proposed in the Engineers' Report. The improvements made in the channel between Morrisburg and Barnharts Island will reduce the slope, and thereby increase the working head available for power plants.

The navigation channel will have the advantage of well defined shore lines, retaining the present high banks in place of the lake-like expanse with wide areas of shallow water and low banks consequent upon the single high head development. It will not require to be buoyed to any great extent, and will give safer navigating conditions during foggy weather, at night and during periods of high winds.

Cost of Machinery

The head available at the Morrisburg plant will be approximately the same as that given in the Engineers Report for the Massena plant, which is put at 29 ft. For this head a type of turbine runner of much higher specific speed may be used than with the high head. This makes the cost per h.p. for the machinery for the double development much closer to that of the high head single development than is indicated in the estimates of the Engineers Report. The weights and heights of the parts of the machinery in the double development will be less than those in the single development, all of which greatly reduces the cost of cranes, runways, columns, etc., per lineal foot of power house.

The foregoing also applies to the Barnhart Island power house of the double development to a certain extent. It

would have an operating head of 53 to 54 ft., and the machinery costs are relatively low per h.p.

In any plan of development the transformers and other high tension transmitting apparatus costs are based upon the k.w. capacity of the plant, and it is immaterial whether his part of the machinery is located in one plant or two.

Flooding Damages

The Engineers Report states that the proposed high head development at the Long Sault be made in two stages:

1st stage—The overflow weirs and regulating works to be carried to El. 231. Power house to El. 250.

2nd stage—The weirs and regulating works to be raised to El. 238. Dykes and embankments to El. 250.

At the first stage of development the maximum power development is impossible, and the flooding is extensive. At the second stage the flooding and backwater effects therefrom are still more serious. This phase of the question is dealt with in appendix D.

Power Development

The Engineers Report gives the total power at the first stage of development as 1,464,000 h.p. and states that a greater amount of power would be generated at the second stage. Owing to unknown winter conditions, however, the additional power obtainable is not dependable. (See pars. 155 and 156 of the Engineers' Report). The double development shows that 1,655,000 primary h.p. can be obtained under similar conditions of flow, giving it an advantage of 191,000 primary h.p. over the first stage of the proposed single development, and a substantial increase over the second stage.

Estimates of Cost

Using the estimates of cost submitted by the Engineers in their report, also their quantities and unit prices so far as they may be applicable to the double development, an analysis has been made of the relative costs of the single and double developments both as regards navigation and power. (See appendix C.) We do not entirely agree however, with the unit prices adopted by them and submit our own estimates (per appendix C1). Opinions may differ widely as to what is chargeable to navigation and what to power, but the method of apportioning the costs is considered equitable.

The Engineers Report makes no allowance for interest charges during construction. As the whole proposition is a commercial undertaking and interest constitutes a respectable percentage of the total amount, it is advisable to provide sufficient to carry on the work to completion. Interest has been computed on the assumption that the single development would absorb 22% of its cost, and that in the double development the Morrisburg works would in like manner take 11% and the Long Sault works 16%.

An allowance of 10% has been made for contingencies, but attention is drawn to the fact that the estimates herein for the double development are liberal, and the contingencies allowed should be a less percentage of the expenditure than in the single development scheme. There is by no means the same element of risk in the two methods of development and particularly that for the Morrisburg structures. Contractors would undoubtedly make due allowance for these risks, and the high specific speeds now being developed for the turbines (particularly for the lower heads) will practically eliminate the necessity of allowing any contingencies for machinery under the double development plan.

An adjustment (or different apportionment) of the channel improvement costs from Galops Rapids to Rapid du Plat should also be made as between the Morrisburg and Barnhart plant in the double development, as set forth in the note attached to appendix C. This reduces the costs of the Morrisburg plant and increases that of the Barnhart Island plant.

The item of land and property damage east of Rapid du Plat in the Engineers Report should be increased as noted in appendix D on flooding. The amount allowed is

insufficient. No such damages occur with the double development.

Conclusion

The advantages of the double development over the single development as proposed in the Engineers Report may be summarized as follows:

1. An old and productive agricultural community (estimated at over 4,000 people) is protected from elimination by flooding and a large drainage area preserved for agriculture.

2. The smaller range in regulation of Lake Ontario together with the higher average stage of the lake is of great value to the lake ports, and also improves river navigation between Lake Ontario and Cornwall. The power capacity of the stream is increased.

3. The river below Morrisburg is improved for navigation and power purposes, but otherwise left in approximately its natural condition as regards its shore line.

4. Navigation for either 20 ft. or 25 ft. draft between Morrisburg and Cornwall can be provided with but little additional expenditure as soon as the Morrisburg site is developed.

5. Moulinette Lock (No. 8) in Cornwall Ship Canal is eliminated.

6. A large stock of power (609,000 h.p.) is made available at a much earlier date, as the Morrisburg development should be completed within four years.

7. Excellent sites for industrial purposes are preserved along the water front extending from Morrisburg to Moulinette.

8. A better distribution of power for operating and industrial conditions, and greater reliability from two sites.

9. Much better ice conditions would prevail during the winter months. This applies particularly to the section between Morrisburg and Long Sault and the operation of the Waddington-Morrisburg power plants, under the layout proposed by the company.

10. The town of Cornwall and the country round about are not menaced by the failure of high earthen dykes and embankments impounding the waters of a new lake some 60 square miles in area.

11. Elimination of many of the most difficult and expensive features connected with the single development, and damages to property well defined from the outset.

12. An enormous saving in the cost of the whole work, both to navigation and power, together with a greater development of primary power.

13. Assuming the Long Sault, development backs the water 2 ft. on the Waddington site, then with a flow of 200,000 c.f.s. the power lost at Waddington site is 40,000 h.p. which capitalized at \$100.00 amounts to \$4,000,000. This is approximately the cost of the proportion of the river improvement between the Galops and Leshman's Point chargeable to power, hence the first stage of development (that is Waddington-Morrisburg site) can very well carry the proportion of the cost of river improvement between Galops and Leshman's which is chargeable to power. After the double development is complete then this cost may be adjusted between the two sites.

APPENDIX A

Regulation of Lake Ontario

Any reduction in the fluctuation of the levels of Lake Ontario under regulated conditions will allow an increase in its average elevation, and a corresponding but much greater increase in the average elevation of the water surface in the pool above Morrisburg dam.

The Engineers Report states that under natural conditions the elevations for the lake varied from 243.41 to 248.95 and the flows from 183,000 to 320,000 c.f.s. The proposed regulation does not materially reduce this range in elevation, and only affects the outflows by raising the minimum to 210,000 c.f.s. making a range of 110,000 c.f.s. under conditions of no diversion at Chicago.

Our studies show that allowing 10,000 c.f.s. for the Chicago diversion it is possible theoretically to keep the

outflow between 200,000 and 280,000 c.f.s., a range of 80,000 c.f.s. for 100% of time and the corresponding range in elevations of the lake will not exceed 2.1 ft. except for 1 month. They also show that practically it is possible to keep the range of regulated flow between 200,000 and 280,000 c.f.s. and the range of elevations at least between 244.6 and 248.95 with only six months out of the period of 60 years having an elevation below 245.3 and within a 2.1 ft. range for 82% of time.

This is a decrease of 27% in range for flows and 30% decrease in range for elevations for lake over those given in the engineers report.

The above quantities are based upon the conditions pertaining during the period 1860-1920 inclusive, but allowing 10,000 c.f.s. for the Chicago diversion.

The effect of increasing the range is shown by the following:

With a two foot range the theoretically possible flow is 200,000 c.f.s. for 100% of the time; 211,000 c.f.s. for 96% of the time, or omitting the low water years of 1895-96 (Aug. 94 to Feb. 97), it is obtainable for 100% of the time; 216,000 c.f.s. is obtainable for 90% of the whole period; 280,000 c.f.s. is the maximum flow.

With a three foot range the theoretically possible flow is 204,000 c.f.s. for 100% of the time, an increase of 2%; 215,000 c.f.s. for 96% of the time, or 100% of period omitting years 1895-96; 218,000 c.f.s. for 90% of the time; 283,000 c.f.s. for maximum flow.

With a four foot range the theoretically possible flow is 206,000 c.f.s. for 100% of the time, an increase of 3%; 217,000 c.f.s. for 96% of the time, or 100% of period omitting years 1895-96; 219,000 c.f.s. for 90% of the time; 269,000 c.f.s. for maximum flow.

With a six foot range, the theoretically possible flow is 211,000 c.f.s. for 100% of the time, an increase of 5 1/2%; 221,000 c.f.s. for 90% of the time; 261,000 c.f.s. for maximum flow.

The above shows that a very small percentage gain in flow is obtained by increasing the range above 2 ft., being only 2% for a three foot range, 3% for a four foot range and 5 1/2% for a six foot range. Any increase in power due to the greater range and its corresponding increase in flow is more than offset by the loss of power due to the lower lake level. The closer regulation is, of course, a great benefit to navigation since it raises the minimum stage of the lake and river as far as the Waddington-Morrisburg site.

Rule for Regulation

It is theoretically possible to maintain the regulated flow between 200,000 and 280,000 c.f.s. and the regulated range within 2.1 ft. A system of regulation may be devised in which these flows will not be exceeded in their limits and still maintain the 2.1 ft. range in lake level for 82% of the time.

These studies have been based upon the elevation of the water surface of the lake and the supply to the lake. Hence, using only this data, it is possible to obtain a high degree of accuracy in the forecast for one month in advance. No doubt any system of regulation will be revised from time to time as additional knowledge of the conditions on the watershed is obtained and as the power load builds up.

Effect of Closer Regulation

The above system of close regulation when applied to so much greater advantage than is possible with the regulated single and double development schemes shows the latter limitation given in the Engineers Report.

The effect of this in comparing the single and double developments is as follows:

(1) To increase the available head for the Morrisburg plant.

(2) This increase in head for the Morrisburg plant is not available for Barnhart Island plant under the single development project as contained in the Engineers' Report. This is due not only to the fixed El. 231 at the Long

Sault, but also to the winter slope of the river between Barnhart and Morrisburg Pool.

(3) That the higher head available for the Morrisburg site in the double development gives higher speeds for the machinery and greater horsepower per lineal foot of power house and other structures, hence a less total cost and less cost per horsepower than is obtainable under the regulation contained in the report of the engineers.

(4) It will be noted that this method of regulation requires less water to be discharged at maximum flow, and consequently less wastage of flood water.

(5) The raising of the average elevation of the lake and the increase in the minimum elevation of approximately 2 ft. is equivalent to dredging the harbors of Lake Ontario and the river down as far as Ogdensburg to that extent.

APPENDIX B

Winter Conditions

The Engineers Report states that it is advisable to operate the reaches between Barnhart and Morrisburg and between Morrisburg and the Galops with an ice cover, but does not state clearly how this ice cover is to be maintained.

Our conclusions are that it would be impossible to maintain a stable ice cover under the proposed single development scheme and that it would be better to attempt maintaining an open channel particularly in the lower reaches. This would be much more easily maintained by the double development plan.

Winters on the Upper St. Lawrence vary considerably. Some are so mild that even the channel between Ogdensburg and Lake Ontario (in which the open season fall is about 1 foot) remains open. Other winters occur in which this reach retains an ice cover for a few days only. During the average winter this section is ice covered.

The section between Ogdensburg and Chimney Island is one in which the velocity is greater than that above Ogdensburg and compares favorably with some of the sections of the proposed channel below the Galops. The lower end of this channel between Chimney Island and the State Hospital frequently chokes with ice coming from the reach above. This reach is only about 4 miles long and supplies all the ice to the above section. It is difficult to believe that much anchor ice occurs in this channel. The result is that the discharge of the river is materially reduced.

The reach between Ogdensburg and Brockville has a lower average velocity than the above and during many winters its closed season is of short duration.

The proposed new channel conditions between Morrisburg and the Galops has several reaches in which it is proposed to excavate in order to reduce the velocity to an average of 4 feet per sec., and the maximum velocity at the surface will be considerably higher. It is difficult to conceive these reaches having a stable ice covering for any large percentage of the winter season.

It must be remembered, that, when considering the ice conditions the average winter and the average ice conditions bear little weight. It is the extreme conditions, the worst that has ever occurred that must be considered. One serious uncontrolled ice jam might wreck the whole proposition.

Mention is made that under the new conditions, the ice cover on the river above the Galops will so warm the water that the Galops will be free of anchor ice. It is difficult to see how the conditions above the Galops will be greatly changed from the present state. The Galops under present conditions do have a large quantity of anchor ice.

Under the single development plan the higher velocities are in the sections a considerable distance west of the dam. This is just the reverse of the condition required for the most successful operation of fighting ice. Invariably the clearing of ice fields must take place from the downstream side.

With the single development scheme the sections next to the dam will freeze first and become the strongest due to the longer period for it to grow in thickness and receive

contributions of ice and snow from reaches farther upstream. The nature of the mass adjacent to the dam is difficult to determine, but it is evident that it may cause a considerable reduction in the discharge of the river and also in the supply to the power house.

Change in Stream Lines

Under winter conditions the flow will have a tendency to concentrate in one part of the channel, thereby increasing the velocity and consequently greatly shortening the life of any ice cover.

Action of Floating Ice

The percentage of border ice that builds up in front of an ice cover may depend to a large extent upon the velocity of the stream at the point of growth. The amount of snow and frazil ice that goes into the accumulation in front of the ice bridge is certainly not so entirely dependent upon the velocity and we cannot agree with some of the remarks of the engineers report on this question.

The capacity of a section of the river for storing ice is not entirely in proportion to its cross-sectional area but depends to a large extent upon the rapidity with which the ice bridge builds up, and the rapidity of the building up of the ice bridge depends upon its facilities for passing the various kinds of ice masses beneath its ice cover. This may be seen at Cornwall or at the bridges which form below Farran's Point or in some of the secondary channels among the islands farther upstream.

Critical Velocity for Border Ice

Our studies of winter conditions along the river do not show that any rigid rule may be made to determine the limiting velocity in a section in order to obtain an ice cover due to growth from shore. There are too many elements involved to make a definite rule. The element of time is an important factor. During a winter with little zero weather or one with alternate cold and warm periods the encroachment of border ice on the midchannel is much less than in a long period of cold weather. The variation in duration of the season for open channel between Ogdensburg and Brockville is a good example of this.

Under the proposed single development scheme an ice cover on the river between Barnhart and Morrisburg will be very uncertain. The following refers particularly to this channel.

(1) The present channel would be changed from its present state of fairly uniform width with comparatively small bays of quiet water and open channel conditions during every winter (except during the periods of 1878, 1887 and 1905 when ice jams occurred) to one of great width with large areas of quiet water and low velocities throughout the reach. Similar in some respects to that at Brockville.

If these bays do not have a permanent ice cover, then the amount of frazil ice manufactured in the reach will be greater than at present. Also the amount of border ice breaking from its anchorage and the frequency with which sections swing out into the main channel may be greater depending to a large extent upon fluctuation of the water stage under operating conditions and the greater effect of the wind upon the wide expanse of the river. On the other hand, if the bays are of more or less permanent nature with an open channel in midstream, then they serve to accumulate the snow which will be swept by favorable winds into the open channel. This snow-ice forms a very disintegrable and difficult mass to handle and even with low velocity currents readily runs under an ice cover. Example: Channel head of Galops to State Hospital below Ogdensburg.

Conditions in a Mild Winter

(2) Consider a winter which is comparatively mild or one in which the periods of severe weather alternate with warm periods. The bays and quiet areas freeze over early in the season to various thicknesses, depending upon the severity of the weather and length of time the water is in an undisturbed condition. The process of these ice areas

breaking from anchorage and floating downstream is often repeated several times.

Change in Climatic Conditions

Consider an average severe winter. Invariably there come periods in December and January when the weather after a lengthy spell of zero temperature, suddenly turns warmer and this may continue a few days or a week. Under these conditions a breakup may occur similar to that described under the previous item on Mild Winter, but with the difference that at the stage when the ice mass is in its most threatening position a sudden change to zero weather might consolidate the aggregation making a repetition of the above a very dangerous matter.

The river between Morrisburg and the Galops has several reaches, namely, at Point Three Points, Point Rockway, Sparrowhawk Point and the Galop channels in which the average velocity approaches closely to four feet per sec., and at all times would be either open or have a very unstable ice cover. These sections are fairly evenly distributed throughout the reach between Morrisburg and the Galop Rapids, so that any condition favoring a breakup of the ice cover would cause these sections to rapidly extend their open water areas until the whole reach opens up in midchannel. The upper end where the average velocities are the greater would open first. Hence the best method of operating the reach between Morrisburg and the Galops is to maintain an open water channel in midstream which will transport (to the reach below Morrisburg) the greater portion of the ice occurring in the reach and thus preventing a congestion similar to that which now occurs between Chimney Island and the State Hospital.

Conditions at the Long Sault Dam

Even if the floating ice is successfully guided over the ice chutes or spillway at the Long Sault dam, it will take considerable water to carry it to Lake St. Francis and prevent a huge mass building up either from the frozen surface of the lake (and this ice surface will take earlier in the upper reach of the lake, due to channel improvements), or the building up immediately below the Long Sault dam. If the spillway is to be used to any considerable extent in winter, then it will add its quota to the accumulation in the lake. Also the shallow portion immediately below the dam will materially augment the contribution to the anchor ice. The rock elevation at the east end of the site of the dam is given as 158 and at the west end 170 and the elevation of the lake surface 154, or only from 4 to 16 feet lower.

Winter Conditions

Winter conditions are such that successful operation of the 4th Division depends upon the ability of maintaining an open channel throughout. The width of the open channel will depend upon the amount of ice to be transported, a greater width of channel being required at the lower end.

With the single development in an average winter, less frazil and anchor ice but more border and snow-ice will probably occur than under present conditions. In a mild winter more border, snow and frazil ice will be formed than under present conditions.

With the double development plan in any winter less frazil, anchor, border and snow-ice will be formed than under the single development plan and less frazil and anchor, nearly the same snow-ice but more border ice will obtain than under present conditions.

Conditions at Power House

The method generally employed in dispersing an ice congestion or ice bridge is attacking the mass from the downstream side and as portions of the ice cover are broken up they are carried downstream clear of the jam. It is necessary to cut this channel of such a width that it will not again be closed by portions breaking from the sides and swinging across before the bridge is dispersed.

Hence a power plant with two or more long channels leading to its ice sluices is in a much better position for fighting an ice congestion in the forebays than a plant de-

pending upon only one. Ordinarily both channels would have a runway for ice but if one chokes up then the other would act as a relief channel, thus giving time for the breaking up of the jam. The advantage of this is evident in the channel at Croil's Island. The great jams of 1878, 1887 and 1905 were caused by both channels at Croil's Island choking. On other occasions one or other of the channels remained open.

The rapidity with which an ice bridge builds up is of course dependent upon the length of channel contributing the ice. In some reaches between Sorel and Montreal this building up is at the rate of a mile per hour. The ice jam of 1905 below Morrisburg built up in the reaches of low velocity quite rapidly. The bridges on the north side of Croil's at times also built up very fast. Another example is the annual occurrence near lock 15 at Cornwall.

The distance from the Waddington-Morrisburg site to the Galops is 16 miles, all of which would be subject to open water conditions, so that under favorable conditions an ice bridge starting at the dam would rapidly build upstream. The layout proposed by the company for the Waddington-Morrisburg development furnishes two independent channels down which ice may be passed. An ice congestion starting at the power house and dam would require to build up a distance of two miles to the junction of the Little River with the North Channel before both channels would be threatened with complete closing. In case one channel did build up this two miles to the head of Ogden, the other channel remaining open would carry the ice contributed by the reaches above, thus giving time to clear the ice choked channel by attacking it at its downstream end. No shutdown of power house would be necessary in order to help clear.

With only one channel leading to power house, this procedure would be impossible and the head of the jam would not be limited to two miles but might advance faster than it could be cleared at lower end, and shutting down the plant in whole or in part would probably be necessary.

If the uncertainties of winter operation make it advisable to carry out the development of power in the 4th Division in two stages, then the section west of Morrisburg should be developed first. In this manner the upper and shorter part of the division (4th) would be changed from its natural state. The lower section from Morrisburg east would be left in its natural condition, the performance of which is well defined.

APPENDIX D

Flooding Damages

The Engineers' Report states that at the first stage of development, flowage will be required up to El. 238, and that at the second stage an emergency elevation of 246 may be reached. This means that both shores of the river will be heavily flooded, and due to the flat slope of the country the drainage area will be affected for a considerable distance beyond, rendering many thousands of acres unfit for agriculture below Morrisburg on both sides of the river.

The villages of Aultsville, Farran's Point and Dickinson's Landing would be badly flooded at the first stage and entirely obliterated at the second stage.

It is proposed to protect the village of Morrisburg by means of a dyke composed of an earth embankment containing a core wall surrounding the village on three sides and pumping the sewerage into the river without making provision for treatment.

The net result of the flooding would be to make the villages uninhabitable by reason of the fact that the farming community which supports them would itself be destroyed, consequently the frontier population from Morrisburg to Dickinson's Landing (inclusive) would have to be removed. The same applies to the American side of the river from Waddington to Massena. Population affected is estimated at over 4,000. The main highways on both sides of the river would require to be re-located at the first stage of development and at the second stage a second re-location

would be necessary in order to afford the remaining farming population necessary access to main thoroughfares and markets. At both the first and second stages the Grand Trunk Railway would have to be raised, and probably portions re-located. Many old and historic cemeteries would be submerged on both sides.

Consideration must also be given to the fact that the compulsory removal of the entire population would entail consequential damages to an amount not easily determinable. In any event the damages direct and indirect would be very great, and the amount allowed in the Engineers' Report does not appear adequate.

APPENDIX C DEDUCTIONS MADE FROM REPORT OF BOARD OF ENGINEERS

	Single Development		Applicable to Double Development	
	Navigation	Power	Navigation	Power
Chimney Island to Morrisburg			\$17,945,630	\$31,554,470
Morrisburg to Cornwall			\$21,556,880	58,731,229
Chimney Island to Cornwall	\$47,002,485	\$97,631,345		
Additional damages	3,000,000	3,000,000		
Engineering & Contingencies	5,000,236	10,063,134	3,950,251	9,028,569
Total	\$55,002,721	\$110,694,479	\$43,452,761	\$99,314,268
Interest during construction	12,100,598	24,352,785	5,965,420	14,154,885
Total	\$67,103,319	\$135,047,264	\$49,418,181	\$113,469,153
Recapitulation				
Chargeable to navigation		\$ 67,103,319		\$ 49,418,181
Chargeable to power		135,047,264		113,469,153
Total		\$202,150,583		\$162,887,334

Note:—In estimating the cost of power development a portion of the cost of channel improvement shown under item 1 should be charged against the Long Sault Power Development.

COMPARATIVE COSTS OF DEVELOPMENTS.

ESTIMATES OF NEW YORK & ONTARIO POWER CO.

	Single Development		Applicable to Double Development	
	Navigation	Power	Navigation	Power
Chimney Island to Morrisburg			\$15,209,491	\$29,496,615
Morrisburg to Cornwall			16,243,174	53,196,051
Chimney Island to Cornwall	\$38,387,143	\$3,608,963		
Additional damages	3,000,000	3,000,000		
Engineering & Contingencies	4,137,814	8,660,896	3,145,266	8,269,266
Total	\$45,515,957	\$95,269,859	\$34,597,931	\$90,961,932
Interest during construction	10,013,510	20,973,889	4,859,142	12,931,593
Total	\$55,529,467	\$116,243,748	\$39,457,073	\$103,893,525
Recapitulation				
Chargeable to navigation		\$ 55,529,467		\$ 39,457,073
Chargeable to power		116,243,748		103,893,525
Total		\$171,773,215		\$143,350,598

Note:—In estimating the cost of power development a portion of the cost of channel improvement shown under item 1 should be charged against the Long Sault Power Development.

COMPARATIVE COSTS OF DEVELOPMENTS

ESTIMATES OF NEW YORK & ONTARIO POWER CO.

ESTIMATES APPENDIX C.				
Without interest	\$110,694,479	\$34,709,917	\$64,604,351	
Interest during construction	24,352,785	3,818,189	10,336,696	
Total	\$135,047,264	\$38,528,106	\$74,941,047	
H.P. (210,000 C.F.S.)	1,464,000	609,000	1,046,000	
Cost per H.P. (including interest)	\$92.40	\$63.30	\$71.70	
ESTIMATES C1				
Without interest	\$95,269,859	\$32,446,276	\$58,515,656	
Interest during construction	20,973,889	3,569,089	9,362,504	
Total	\$116,243,748	\$36,015,365	\$67,878,160	
H.P. (210,000 C.F.S.)	1,464,000	609,000	1,046,000	
Cost per H.P. (including interest)	\$79.40	\$59.15	\$64.90	

Note:—In estimating the cost of power development a portion of the cost of channel improvement shown under items 1 and 6 should be charged against the Long Sault Power Development.

RELATIVE H. P. COSTS.

THE DISINFECTION OF PUBLIC WATER SUPPLIES AND ITS RELATION TO PUBLIC HEALTH

Explains How Typhoid Epidemics Begin — Decrease in Death Rate Follows Use of Chlorine — More General Use of Liquid Chlorine for Disinfecting Water Supplies

By C. A. Jennings

Chicago, Representative, Wallace & Tiernan, Inc.

CHLORINE is a greenish yellow gas, it was discovered in 1774 by Scheele, a Swedish chemist. One volume of liquid chlorine is equivalent to 455 volumes of chlorine gas. Chlorine was formerly produced by chemical means, but, latterly it has been manufactured by the electrolytic decomposition of salt brine. Until recently, chlorine was known principally through its use in the form of chloride of lime (bleaching powder, hypochlorite of lime or hypo). This is produced by the action of chlorine gas upon slaked lime in lead lined chambers. Coincident with the development of the electrolytic method of producing chlorine, there came the development of the machinery for liquifying the gas. As a result, chlorine is now shipped in steel drums of various capacities, including tank cars containing 15 tons. As shipped, it is in liquid form, under a pressure of about 80 pounds, the liquified gas is dry and is between 99.5% and 100% pure chlorine; the variation in the degree of purity being slight. As long as the gas is dry it will corrode few metals.

Hypo Tried as a Germicidal Agent

In 1906 one of the filter companies conceived the idea that drinking water could be made out of the foul, fermenting liquid called water in Bubbly Creek, a branch of the Chicago River. After some ten months of experimenting, work was started on a 5,000,000 gallon per day mechanical filtration plant. Upon its completion, it was necessary to carry on experiments for a long period of time during which all known processes of water treatment were tried with only partial results. As a last resort, in the summer of 1908, experiments were made with hypochlorite of lime or hypo, as a germicidal agent, at the suggestion of Col. George A. Johnson, consulting engineer. The writer was employed at the time as a sanitary engineer by one of the three companies interested in the experiments. The results were extremely gratifying and there followed the development of the process of disinfecting water by means of chlorine compounds, specifically hypochlorite of lime or hypo. Within a month, the water supply of Jersey City, N.J., was being sterilized; soon Little Falls, N.J., adopted this treatment and one after the other, cities all over the United States began using hypo. Before three years had passed, there were more than 500 cities disinfecting their water supplies by means of hypo.

Previous to this development, water supplies that needed purification were treated by storage, plain sedimentation, sedimentation and filtration, coagulation and filtration, etc. If a well water supply or a clear mountain stream or clear lake supply became contaminated, there was only one thing to do, namely, filter the supply even though it was already a clear water, quite often this placed a very heavy financial burden upon municipalities and furthermore, a filter plant required months for construction. Disinfection by hypochlorite of lime found widespread of lime found widespread favor especially in such cases. Furthermore, the standards of sanitary science had increased along other lines and now it was possible to make more stringent regulations regarding the quality of water supplies. The surface water supplies were becoming virtually open sewers as a result of the increased urban population, the sewerage of most communities bordering upon the sources of water supplies and the increasing amount of trade wastes discharged into waterways. Disinfection of water and sewage came at a very auspicious and opportune time. It was adopted as an adjunct to filtration and other forms of water

purification plants. At no time have the advocates of water disinfection argued that disinfection was a substitute for filtration. The principal function of filtration is clarification and incidentally a considerable bacterial reduction takes place but this is not selective as to the kind of bacteria removed. The only function of water disinfection is to kill bacteria and it was soon proven that this treatment had a selective action on the disease producing organisms. This made it an invaluable adjunct to other purification systems.

First Chlorine Control Apparatus Installed

In 1912 the first control apparatus to use liquid chlorine or chlorine gas was installed. The use of a chlorinator handling a pure gas, permitting of accurate knowledge at all times of the quantity of chlorine being used; elimination of uncertainties as to the strength of the chemical being used; overcoming the odor of hypo and its corrosive action on metals; the fact that no chemicals had to be mixed up in solution tanks; lower cost of treatment; the fact that there was no deterioration in the strength of the disinfecting chemical while using or while being stored — all the points showed the great superiority of the use of chlorine over hypo. At the present time there are some 2,000 cities using liquid chlorine for water disinfection and very few still use hypo. In order to conceive the quantity of water is sterilized daily by liquid chlorine, it is estimated that this would be equivalent to the amount of water passing over Niagara Falls in one hour, in other words, about four billion gallons.

Water borne typhoid fever epidemics are on record during many years. They take place even today but there is no excuse for them now, nor is there any excuse for them to assume any degree of severity. Liquid chlorine treatment safeguards against such occurrences.

How Typhoid Epidemics Start

Shortly after Christmas, 1885, a man living above the city of Plymouth, Pa., returned home and took to his bed with typhoid fever. His excreta, unsterilized, were deposited upon the snow covered bank of a mountain brook which emptied into a lake reservoir from which the water supply of Plymouth was obtained. In March there occurred the annual spring thaw. The excreta entered the brook and then the reservoir. The resultant epidemic caused 1,000 cases of typhoid fever and 114 deaths in this town with a population of only 8,000. One person out of every eight had typhoid and one out of every 70 died with it. Continuous disinfection of the water supply at that time would have prevented such a terrible catastrophe.

Two interesting epidemics occurred from a more unusual and more difficult cause to locate, one being at Elgin, Ill., and the other at Bloomington, Ill.; both within the last few years. At the Elgin Watch Co. the drinking water supply from the city mains was pure. An industrial supply was pumped from Fox River for manufacturing purposes, fire protection, etc. This supply was contaminated with the sewage of Elgin and other cities. However, there was a cross-connection between the two systems with a check valve in the line to prevent the river water which was under considerably higher pressure, from being forced back into the city mains. The purpose of the cross connection was to insure the plant fire protection at all times even in the event of the failure of their own private system from Fox River. This is common practice with manufacturing concerns as it enables them to secure a lower fire insurance rate. On one occasion the check valve did not seat tightly and a very serious epidemic occurred among the employees. The damages paid by the company are said to have exceeded \$200,000.

At Bloomington, Ill., the Chicago & Alton R. R. shops had a cross connection with the city water supply. On one occasion their creek supply failed and they pumped for industrial purposes from a 33-in. outlet sewer, the contents being a mixture of sewage and creek water. The check valve between the two systems did not seat tightly and the grossly contaminated water entered the drinking water system. This caused some 400 cases of dysentery, 133

cases of typhoid, and 21 deaths. It is estimated that the damages ultimately to be paid by the C. & A. R. R. Co. will exceed \$175,000. In some states, notably Minnesota, cross connections of this sort are absolutely prohibited by law and the state boards of health make inspections to see that this law is complied with.

Several large manufacturing plants with dual water systems such as the Universal Portland Cement Co. at Bufington, Ind., and the B. F. Goodrich Co. at Akron, Ohio, chlorinate the industrial water supply. Then, if workmen should use this water for drinking purposes, in spite of notices to the contrary, the water would be innocuous and no disease would result therefrom. Most manufacturing establishments find it pays to take this precaution.

Leaky Well Casing at Lansing

The water supply of Lansing, Mich., is obtained from wells in five different sections of the city, all wells being about 450 ft. deep. The mains are all interconnected. It seems that one of the wells had a leaky casing in the summer of 1919 when the river was high. The high river backed up one of the sewers, sewage leaked out through the joints in the sewer pipe, this sewage permeated the soil and found entrance into the suction pipe of the deep well. The entire city water distribution system became contaminated, causing some 3,000 cases of dysentery, 82 cases of typhoid and 11 deaths. Liquid chlorine treatment was installed immediately at Lansing and has been used continuously since that time as a form of health insurance against the possible return of similar conditions.

At Tonawanda, N.Y., warnings had been given frequently for the State Department of Health from 1912 until 1919 to the effect that their water supply from Niagara River should be purified. An accident to the intake precipitated the epidemic about which they had been warned and during the months of July, August and September 1919, there were 236 cases of typhoid. Liquid chlorine treatment was installed after the epidemic had been discovered and this brought it to a sudden termination. It should have been installed at the time the city received its first warning.

Through carelessness, the chlorine apparatus at Alpena, Mich., was not operated for eight days in December 1919 because the supply of chlorine had become exhausted and no attempt was made to replenish it from any city nearby using the same treatment. Nine people paid for this error with their lives and there were 107 cases of typhoid. Civil action was brought against the city and the city manager was discharged. A duplicate automatic chlorinator was immediately ordered to make certain that there should be no cessation in the treatment due to the possible failure of one of the chlorinators.

At Pittsburg, Cal., the chlorine apparatus was out of service for one day a few months ago. It was shut off while making some minor repairs and adjustments. Untreated water was pumped into the mains and no notice was given to the consumers to boil the water. Out of a population of 5,000 there were 100 cases of typhoid even though the apparatus was out of service only one day. Since that time Pittsburg has been sued by 21 people who were sick and the damages claimed amount to \$140,000. A second or reserve apparatus was installed after the epidemic.

In May and June 1920 Greenville, Ky., had 51 cases of typhoid and 7 deaths, and Xenia, Ohio, in August and September 1918 had an epidemic of 44 cases of typhoid fever. In each case this was due to the use of hypochlorite of lime of unknown strength and not having any check on the amount being applied. The Ohio State Health authorities reported: "It is advisable that the company abandon the hypochlorite method of disinfection and employ the more dependable and up to date method using liquid chlorine." Since these two epidemics each city has installed chlorine control apparatus to use liquid chlorine.

Epidemic at Salem

The population of Salem, Ohio, is 10,000. During October and November 1920 there were 6,000 cases of dysentery, 900 cases of typhoid fever and 50 deaths. The

water supply was from wells and had always been considered above suspicion. Sewage found access to an abandoned pipe leading to the common suction well and so contaminated the entire system. The Bulletin of the State Board of Health of Ohio pointed out that giving due weight to the number of lives lost, number of people who were sick and recovered, the funeral expenses, doctor fees, loss of time of wage earners, expenditures for medical services, drugs, nurses, etc., the appropriations made by the State and by the Red Cross, the Salem epidemic showed a cost of \$450,000. Chlorine control apparatus installed after the epidemic cost about \$900 each. The daily cost of treating the entire city water supply of Salem will be less than \$1. To think that with such a small investment for apparatus and an expenditure of \$350 per year the Salem water supply would have been made safe and saved the \$450,000 as well as the lives that were lost. Damage suits aggregating nearly \$300,000 have been filed against the city of Salem as a result of this epidemic.

Even a filter plant requires chlorine as a final or auxiliary treatment. In November 1920 the chemist of the filtration plant at Anderson, Indiana, shut down the chlorine apparatus and allowed it to be idle for 20 days. Following this there were 18 cases and 2 deaths from typhoid fever.

The deep well water supply of Corning, N.Y., became contaminated as a result of a flooded condition of the adjacent river. The inhabitants suffered an epidemic of typhoid fever even though this supply had never been contaminated before and even though it was obtained from deep wells. Since the epidemic there has been installed chlorine control apparatus in duplicate.

Decrease in Typhoid Death Rate in U. S.

In the year 1907 the census registration area showed a population of 41,758,000 with a typhoid death rate of 30.3. In 1919 the rate had decreased to 9.2 and the population canvassed was 85,148,000. This represented a saving of lives equal to 21.1 for each 100,000 population or on the basis of a population for the United States of 110,000,000, the saving amounts to the enormous total of 23,200 lives. In other words, if there had been the same typhoid death rate throughout the country in 1920 as that in the registration area for the year 1907, namely, 30.3, there would have been 23,200 more deaths from typhoid fever than actually occurred. This represents a saving to the country of the enormous total of \$116,000,000.

It is probable that no two water works pumping stations are identical in layout of pumps, pipe lines, etc., nor in the operating conditions. For this reason a special study must be made of each proposed installation of chlorine equipment and the apparatus adapted to the local conditions is specified and the proper method and location of installation detailed. Some conditions necessitate the application of the chlorine as a gas, others as a solution. Often there is no way in which to apply chlorine by gravity and a positive head or pressure at the point of application must be overcome. In larger cities the amount of chlorine used daily may be considerable, comparatively speaking. However, in many of the smaller cities, the volume of the water treated is so small and the dosage of chlorine so slight, that it may entail difficulties in the control of such minute quantities of chlorine. For example, the smallest chlorinator has a minimum capacity of .01 lb. of chlorine per day or in other words, .007 ounce per hour. This is an extremely small amount of gas to regulate accurately. For the average water supply this would sterilize water at a rate of 5,000 gallons per day or about 4 gallons per minute. It is not considered a practicable proposition to try to chlorinate smaller quantities of water.

Some waters with low turbidity, color, organic matter and unoxidizable mineral matter require small amounts of chlorine for proper disinfection, possibly as little as one pound per million gallons or .12 p.p.m. (parts per million). There are highly colored and turbid waters and even some clear waters with large amounts of organic or oxidizable mineral matter that require several times this amount of chlorine for proper disinfection. Here again it is necessary

to make a study of the water to be treated and determined upon the proper rate of application. The average amount of chlorine used on water supplies is probably close to 2.5 pounds per million gallons or 3 p.p.m.

In the regular operation of the water treatment plants it is a very simple matter to determine if the correct quantity of chlorine is being applied without waiting for the results of a bacteriological examination. This is accomplished by testing the treated water for free or excess chlorine by means of the orthotolidin or starch iodide methods. Quantitative results can be secured if desired. At the current price for chlorine, the cost of disinfecting the average water supply will approximate 30 cents per million gallons. Ordinarily, the time period of reaction is very short varying from a few seconds to 15 minutes, depending upon the character of the water being treated, quantity of chlorine used, temperature of the water, etc. Ordinarily the chlorine is applied to the water as it is being pumped into the distribution system, thereby not requiring reaction chambers.

Chicago Uses Chlorine Control Apparatus

The city of Chicago has made a very thorough and exhaustive study of the applications of chlorine to its water supply. There are ten pumping stations taking their supplies from a few cribs, the distances of same from shore varying from two to four miles. The highest recorded death rate from typhoid fever in Chicago was in 1891 when the figure reached 172 per 100,000. Various remedial measures were taken subsequent to this and beginning in 1900, these measures were very effective, such as the opening of the Drainage Canal and thereby diverting the city sewage from Lake Michigan into the Chicago River and eventually the Mississippi River. The first preliminary work of disinfection of the water supply was done in 1912 at some of the cribs. By December 1916, chlorine control apparatus had been installed in all of the pumping stations and since that time all of the water pumped has been chlorinated.

For the period of 1906-1911 before disinfection, the average annual death rate was 14.9 per 100,000. During the years 1912-1916 while experimenting and equipping the stations with chlorinators, the rate dropped 50% to 7.1. For the years 1917-1920 inclusive, while sterilizing the entire water supply continuously the rate has been 1.36, placing Chicago in a very enviable position. It would seem that water borne typhoid fever has been practically eliminated in Chicago. Sanitarians feel that there is a certain amount of typhoid fever called "residual," which may occur in cities with absolutely pure water supplies. Chicago has approached or has possibly reached that stage. The following statements are quoted from "A Report on Typhoid Fever and its Control in Chicago," by Dr. John Dill Robertson, Commissioner of Health, Chicago, dated 1919:

"In Chicago during the first nine months following complete chlorination of the water supply, which was consummated in the latter part of 1916, the death rate from typhoid fever was reduced by 71.44%. Undoubtedly the application of chlorine treatment has contributed materially to the very gratifying reduction which has placed the city of Chicago in the lead of all cities of its class in the United States during the present year. It can be demonstrated that many times the cost of chlorinating the water has been saved to the people of Chicago in the saving of lives and in the prevention of sickness. The use of chlorine in liquid form has now become widely prevalent and is approved by sanitarians and health authorities generally. The marked reduction of the typhoid fever mortality in Chicago shows emphatically the efficacy of the measures employed to control the disease such as the chlorination of the water supply, control of lake dumping, pasteurization of milk, campaign against the fly, etc."

Water disinfection by means of liquid chlorine, although not solely responsible, nevertheless has been in a large measure the cause of the remarkable lowering of the Chicago typhoid death rate. What has been accomplished in Chicago has been duplicated in many other cities in this country where chlorine disinfection of the water supply has

been practiced. A careful study of the typhoid statistics will prove this statement to be true. Liquid chlorine treatment has been one of the most potent agents in the reduction in the typhoid as well as in the general death rate throughout the country during the past few years. This would be in line with the Mills-Reincke phenomenon, which indicates that by eliminating intestinal disorders there is accomplished a material reduction in various other seemingly dissociated death rates. This theory has been pretty generally accepted by sanitarians and many proofs can be cited of it.

Some cities have had specific problems to solve in connection with the disinfection of their water supplies. For example, there are times when the chlorinated water at Milwaukee irrespective of the amount of chlorine applied, tastes so strongly that it can hardly be used for drinking or cooking purposes. Intensive study of this problem has proven this to be due to the discharge of trade wastes into the lake or into one of the rivers emptying into the lake. The first waste which caused trouble was from a phenol or carbolic acid plant. After eliminating this, the taste returned and this time was traced to a gas house on one of the rivers. The plant was discharging coke quenchings into the river and when the wind was in a certain direction, this river which was practically stagnant, polluted the lake and the dissolved matter found its way to the waterworks intake and caused the city water to have a very noticeable taste after chlorination. Remedial measures are being considered at the present time.

Treating Industrial Wastes

At Marquette, Mich., a creosote plant is located a few miles from the city and from the waterworks intake. When the wind is in a certain direction, the chlorinated water develops a very decided taste and odor due to the creosote wastes discharged into the lake. The owners of this plant are owners of one of the largest iron ore companies, and previously refused to treat their creosote wastes to render them less obnoxious on the ground that these wastes are not harmful to the health of the people and in fact they claim that they can prove that a small amount of creosote is beneficial. Moving the intake at Marquette further out into the lake and into deeper water has had no beneficial effect. Recently they co-operated with the Michigan State Board of Health to eliminate these wastes and the results are very promising.

A special use for chlorine was developed at Champaign, Ill., in connection with the Champaign & Urbana Water Co. supply. The water is obtained from wells containing 2.0 p.p.m. iron. Several years ago an iron removal plant was installed and for about two years this gave good results, removing about 90% of their iron. Then there appeared in the mains and reservoir growths of crenothrix. Various expedients were tried and finally liquid chlorine was given a trial. The results were positive and strikingly successful from the start. Beneficial results were obtained immediately on the growth of crenothrix. As a result of these experimental data being so encouraging, a permanent liquid chlorine apparatus was installed and has been in successful operation for several years. This has entirely eliminated the crenothrix growth which was so troublesome. In this case, chlorine was used not as a germicide but to kill crenothrix. Similar installations for crenothrix elimination have been installed at Frankfort, Ind., and Eau Claire, Wis.

Chlorinating Swimming Tanks

During the last few years there have been very notable advances in the subject of swimming pool sanitation. Very radical changes have taken place in the design of pools as well as the treatment of water in the pool. Formerly little consideration was given by the average person as to the sanitary condition of the swimming pool. Now such organizations as the International Committee of the Y.M.C.A. as well as many colleges, boards of education, etc., will approve of no plans for swimming pools without the incorporation of a recirculating pump, filter and disinfection treatment by liquid chlorine. The modus operandi is to

withdraw water from the deep end of the pool by the recirculating pump at a rate sufficient to empty the pool in about 16 hours, the rate depending upon the probable number of bathers, pass this water through a filter for clarification purposes and then treat it with a solution of chlorine on its way back to the shallow end of the pool. This keeps the water both clear and bacterially pure irrespective of the number of bathers using the pool. By this system of recirculation, filtration and disinfection, a large financial saving can be effected yearly in view of the fact that it is not necessary to empty the pool entirely except after a long period of time. Without this system the pools are emptied weekly and in some cases more often. They are scrubbed down, fresh water placed in the pool and this water must be heated from the temperature of the city water up to about 74 degrees Fah. For the average sized pool this will cost about \$20 for the coal alone for each refilling and this does not include the cost of the water nor the labor involved. Ordinarily the entire installation of a pump, filter and chlorinator can be saved in a comparatively few months. Furthermore, the quality of the water in the pool is much better continuously than without this method.

Chlorine disinfection of swimming pools is very satisfactory and very efficient because of its low first cost and negligible operating cost of about 5 cents per day; the fact that the results are positive; it is possible to determine by the previously mentioned chemical tests whether or not the proper quantity of chlorine is being applied; the strength of the chemical is constant; the rate of application can be changed as desired; the efficiency of the treatment is not dependent upon the production of a clear and colorless water as is the case with some of the other methods of pool disinfection and the fact that not only is the water being recirculated sterilized but also this water is charged with sufficient excess chlorine to act as a sterilizing agent upon the entire pool.

Liquid chlorine has been successfully used in the New England states to kill anthrax, a deadly spore forming type of bacteria found frequently in the tanning industry.

Chlorine has been used to a much more limited extent in the treatment of sewage than water. Sewage treatment (purification) is aimed essentially at the elimination of nuisance by reducing the suspended organic matters in the raw sewage and is not designed to effect a bacterial reduction except incidentally. Chlorine is a germicidal agent and as such is used as an adjunct to sewage treatment plants to protect water supplies, shell fish beds, etc. In some cases, chlorine has been used on crude sewage but because of the large particles of suspended matter in raw or crude sewage, it is not recommended as standard practice, although there may be some isolated cases where such treatment is called for.

Thus it will be seen that of the various sanitary measures that have been adopted in recent years, liquid chlorine disinfection of water supplies has been instrumental in the saving of thousands of lives throughout the country by the reduction of the typhoid fever death rate.

The "American City" magazine stated recently: "The city that chlorinates its water supply is providing itself with good insurance against a criminally high death rate from typhoid fever." The Michigan State Board of Health Bulletin recently stated: "City officials are learning that it is much cheaper and safer to chlorinate water supplies than to try to keep the course in a state of natural purity. During 1920 typhoid fever cost citizens of the state more than \$1,500,000. Liquid chlorine water disinfection is a municipal life insurance policy costing a premium of 2 cents per capita per year—an insurance policy that should be purchased by the officials of every city having a water supply to which there is any chance to lay any suspicion as to its sanitary quality. The premium is small—the benefits are immeasurable. Paper read before Minnesota Section of American Water Works Association, Nov. 4, 1921.

J. W. D. Farrell, assistant superintendent of water-works for Regina was the speaker at the regular meeting of the Saskatchewan branch of the Engineering Institute of Canada on Jan. 12.

NEW GASOLINE REVOLVING SHOVEL

THE Bucyrus Company of South Milwaukee, Wis., has just put on the market a gasoline revolving shovel that contains a number of features which are quite new in excavating machinery. This machine which is known as their 30-B gasoline shovel, marks a distinct advance in the design of excavating machinery and it is expected that it will find a splendid market in those districts where coal is expensive or feed water scarce or of poor quality.

This machine is particularly well adapted to suit operations which are intermittent such as gravel pits, clay plants, etc., it not being necessary to keep the machine steamed up whether the shovel is working or not. For a good many years now the dragline excavators made by this company have been operated by gasoline engines but the application of this power to a revolving shovel involved somewhat more difficult and intricate problems, chief of these being the efficient transmission of power to the thrust



without excessive complexity in design, and the obtaining of digging power equal to that of a steam machine of similar size. This new machine possesses the same digging characteristics of the steam shovel with its quick reversals, its powerful thrust of the dipper and its dependability.

Some features which make this shovel of peculiar interest to contractors are the following:

First, it has fewer parts to maintain and keep in order. It possesses the flexibility of the steam shovel even to the shaking of the dipper to relieve it of sticky material. The engine is entirely enclosed and dust proof which is a point worth considering especially in connection with excavating work. It may be equipped as a dragline excavator, a crane, or a clamshell machine with very simple changes which may be made in the field.

Before the shovel was placed on the market it was subjected to a six months tests under practical service conditions working with sticky clay and clearly demonstrated its efficiency.

A bulletin which gives full information together with illustrations of this machine is about ready to be issued. A copy of this will be gladly sent to all those interested.

George A. Goodman, contractor, was elected president of the Builders and Contractors Association of Essex County at the annual meeting held at Windsor on Jan. 10., in the association's quarters, Ferry street. Lorne Lang was elected to the office of vice-president; Harry Turner, secretary, and William Laesser, treasurer. The incoming board of directors consists of George A. Goodman, Lorne Lang, representing the sheet metal contractors; William Crawford, plasterers; J. Walker, general contractors; A. H. Bennett, cement workers; George Bertini, tile; Charles Paddon, plumbing; George Clarke, carpentering; T. W. Brook, painters; W. H. Thompson, bricklayers; F. D. Reaume, electricians; and T. J. Eansor, structural steel.

THE MAINTENANCE OF CLEAN FILTERING MEDIUM IN SEWAGE FILTERS

Describes Use of Insects for Cleaning Sewage Filters. They Eliminate Clogging and Ponding. Forking Not Necessary.

By Herbert D. Bell, A.I.C., F.C.S.

IN view of the research which is being carried on at the present time on methods of sewage purification, without filters—I refer, of course, to the use of activated sludge, whether by the air-blowing method at Manchester, or by the processes of the paddle-wheel at Sheffield, or the screw at Bury—there still remains a wide field of investigation on the possibility of the maintenance of filters, without having to resort to mechanical washing of the material at the end of every ten to fifteen years. It is with regard to the latter subject that I have something to say, which I trust will help other managers to keep their filtering medium clean, in order that sewage filters may continue to carry out the function for which they were designed. My remarks apply chiefly to the media in percolating filters, although contact filters may also derive benefit from the process of cleansing which I am about to describe. As a foreword, this paper does not pretend that all kinds of filtering material will last forever, but presupposes that the material of which the filtering media is composed is able more or less to resist frost and the ordinary natural forces, and is composed of, say, furnace clinker, slag, saggars, and such like media.

On many of the sewage works under your control there may be some filters which are showing signs of clogging up, the first notification of which is generally a ponding of the tank effluent on the surface of the filter. Some of you may have filters which apparently do not seem able to do anything else but pond, and no amount of rest appears to give them any relief. You may also have filters which pond only under stress of work or only during the winter months. To all who have the control of percolating filters with automatic or mechanically driven distributors, or fixed sprays, I suggest a means of cleaning the surface and the lower strata of the media by means of an insect called *Achorutes viaticus*, or the water springtail. In a publication entitled "Insect Life on Sewage Filters" it was demonstrated that this insect would prevent the formation of gelatinous or greasy growths on the surface of circular percolating filters, which cause the formation of impervious layers, thus producing ponding. Further it was also proved that if a filter became so foul on the surface with these growths that it was quite impervious to tank effluent, the addition of these insects caused the breaking up of these growths, and gradually (on complete colonization) brought the filter media back to its pristine cleanliness. It is evident therefore that the presence of these insects extend the life of the filter, and enable it to work for longer periods without rest, and also to produce a higher percentage purification.

The Use of Insect Life

The experiments referred to in "Insect Life on Sewage Filters" were carried out with wide glass tubes for filters, and well graded, sterile cinders, constituting the media, the top three inches being cinders which passed through a $\frac{1}{4}$ -in. mesh, but were rejected by $\frac{1}{8}$ -in., the latter being much finer material than is generally found in practice. At no time did the filter, in constant possession of *Achorutes viaticus* show signs of ponding, although worked at a higher rate than the other filter, which contained exactly similar medium, and grading, but did not possess any of these insects. The latter filter soon commenced to show signs of ponding, which did not disappear with resting, and eventually became quite impervious to tank effluent. On the addition of these insects to the dirty filter, the surface began to clean up, and after a few weeks became quite clean down

to the bottom of the filter. The surface of neither filter was disturbed in any way throughout the whole experiment.

At Stratford-on-Avon the insects appeared on the filters naturally, or rather I should say on one of the filters, and their number increased to such an extent that 133 bucketsful were obtained from the pathway surrounding this particular filter. The other seven filters were treated to 19 bucketsful each, and from February, 1910, to this day, no fork, rake or other implement has been used to lessen the surface of these filters, neither do they show any sign of ponding during the last three or four years before I left Stratford-on-Avon.

These insects did not appear naturally at Barnsley sewage works, but I was able to procure one or two tins full from my friend Mr. D. Robertson, manager of the Darfield sewage works. Some of these insects were put immediately on to very dirty patches on the surface of one or two filters, and the remainder were transferred to the fine surface of an experimental pipe filter, to which was added, by means of a small syphon, tank effluent six days per week for some months. This small filter acted as a colonizing or propagating filter, and from time to time a handful of media containing the eggs of the insect were transferred to dirty portions on the large filters, until at the present time there are three large filters well colonized, and the remaining filters are showing evidence of healthy propagation. None of the nine large circular percolating filters on the Barnsley sewage works have been forked since the summer of 1919, and ponding is gradually becoming less frequent, and is in fact absent on those filters which are well advanced in colonization of *Achorutes viaticus*.

Forking as a Cause of Clogging

It has been somewhat of a passion amongst sewage works managers, immediately a filter began to pond, that it was necessary to fork up the medium at that particular point, and in some instances I have known of forking taking place whilst the filter medium was wet. For many years I have held that forking or disturbing the surface in any way was a fallacy, and further I believe that forking in many cases has been mainly responsible for the clogging up eventually of many filters in this country, and I propose to give you reasons for this assertion.

If a fork is plunged into the medium, and its contents lifted and turned over, as is done when forking a garden, it tends to disintegrate a portion of the growths, so that on restarting work again on the filter after its rest, the finer portions of the medium which are still partially covered with the growths (referred to before) are washed by the tank effluent lower down into the filter, becoming retained by the dirty portion of the coarser material below, which is at a point beneath which the fork will not penetrate on the next occasion. These growths will then start once more to produce an impervious layer beneath the surface. At the same time, the medium on the surface will become pieced together with these growths, thus re-forming an impervious layer on the surface.

With these two layers of growths increasing on two planes one immediately above the other no air can get through, and the result is that no aerobic organisms can live or be propagated, and finally clogging becomes permanent on that portion of the filter, unless some biological force comes into play.

There are on many filters a large number of worms, and undoubtedly they do much useful work in keeping numbers of air-channels open, and also there must be other forms of life other than bacteria which help to produce a state which lengthens the period before actual total clogging becomes general. During resting periods a little disintegration undoubtedly takes place, but the general result is that the growths causing the clogging being out of sight (after forking) are believed to be absent. Thorough disintegration cannot take place without biological forces, and no mechanical loosening of the surface, in my opinion, will prevent the gradual clogging up of the media, which as time goes on renders the filter less useful as a purifying agent,

and finally the whole of the material is taken out and washed or renewed before replacing in the filter.

Some of you may say, "We do not fork a filter medium like we fork a garden." Perhaps you do not. You may insert your fork vertically downwards, and gently prise the handle backwards with a slight jiggling movement, bringing the fork out so as only to sit the dirt in the tight medium. The effect is the same as in the other method, but perhaps tends to delay a little the actual clogging up of the media, as a larger proportion of the fine media remains on the surface; but the sifted particles being coated with some of the growths settle down on the coarser medium below and re-form at a level below which the fork will not reach on the next occasion. Further, the act of forking tends to destroy the original grading of the media, as a properly constructed filter should have from four to six inches thick of its finest grade of material on the top. Forking causes a distribution of the fine particles of the material, coated with these objectionable growths, to intermingle with the coarser material below the surface, which consequently impedes partially purified liquid from getting away from the top layer of the coarser material; and therefore these dirty particles tend to absorb from the partially purified liquid some of its oxidized nitrogen and oxygen, to the detriment of the final effluent leaving the filter.

If for some reason you have been unable to obtain the necessary biological organisms to keep your filters clean, it would be far better to remove entirely the top layer, wash and then replace it after screening, rather than to fork the surface at all. The best way, I consider, is to try to colonize your filters with some form of life, which not only disintegrates and removes objectionable growths which have formed, but will also prevent the re-formation of such growths. Sewage filters, as most of you know, are not straining filters like waterworks filters, but purification is produced by active contact with purifying organisms which can only carry out their functions in the presence of air, and therefore the more porous the fine surface of your filters can be maintained, the more likely will purification be carried on with success, and the life of the filter extended before the ultimate breaking up of the filtering media renders its renewal imperative.

Colonization of "Anchorites Viaticus"

As stated above, the Anchorites Viaticus did not come naturally to the filters at Barnsley sewage works, and, furthermore, the media is such that it does not offer the same cavities for the protection of the eggs and the young insects as ordinary furnace clinkers; yet in spite of this handicap we have been able to get colonization complete on one filter, nearly complete on two others, and evidence of the presence of these insects on the remaining six filters within a period of two years.

The total capacity of all the circular filters at Barnsley is 15,790 cu. yds. These filters deal with a tank effluent whose average dry-weather flow is approximately 1½ million gallons, and as much as 2,900,000 gallons have been dealt with by these filters in twenty-four hours, so that it is possible for other managers with larger works than I control eventually to colonize their filters with this insect, certainly within a period of three or four years.

During the period of colonization it will be noticeable, first, that ponding will become less frequent until it disappears altogether; secondly, that there will be a gradual increase in the volume of tank effluent which the filters will be able to cope with and purify; thirdly, there will be noticed an increase in the percentage purification (after settlement); and, finally, there will be noticed an increase in the amount of suspended matter passing away in the effluent from the filter. Generally speaking, there should be a larger amount of suspended matter in the effluent from a percolating filter than in the tank effluent distributed on to its surface, as, given that the surface is porous, particles of suspended matter in the tank effluent should be able to pass through, and in addition there will be a breaking up of the colloidal matter in the tank effluent, a portion of which will be changed into suspended matter.

These are signs of partial colonization while the filter is at work, and when it is resting it will be noticed within three days (on circular percolating filters) that concentric rings appear on the surface of the media. These rings are of two varieties, the one being clean and the other dirty or discolored. On examination of the material with a pen-knife immediately below the surface of the clean ring, either there will be found large numbers of the insect at work, or there will be found large numbers of its white cast or sheath, showing that the adult insect has moved to a portion of the media where there is more food—that is, where there is a greater deposit of the growth which has been the immediate cause of the dirty appearance. At the place where these white casts or sheaths are found, the eggs of the insect can be seen with the aid of a small magnifying glass, and appear to be in packets of small yellow globular cells. As resting continues and colonization has become more complete, the whole surface of the material will appear to be even cleaner than it was before placing in the filter, and also several inches below the surface will bear out the same result. If colonization is approaching its zenith, large numbers of these insects will pass out with the effluent from the filter, and as the insect is capable of standing on the surface of a liquid by means of the hairy ends of its legs, it is an easy matter to collect them in a ladle or bucket with the effluent for distribution on filters where their number is not so numerous. Abstracted from paper read at the Annual Meeting of the Yorkshire District of the Association of Managers of Sewage Disposal Works.

BUILDING RECORD IN DECEMBER

CONSTRUCTION activity in Canada during the month of December, amounted to \$19,118,500. This is the second largest December total on record, being exceeded only once, and that in December, 1912, when \$31,125,528 was expended. The figures for the different provinces are as follows:

	No. Projects	Value
Ontario	732	\$8,959,900
British Columbia	147	5,197,000
Quebec	187	2,995,900
New Brunswick	13	1,147,500
Manitoba	17	342,600
Nova Scotia	36	198,600
Alberta	13	139,500
Saskatchewan	15	137,500

Total for Dominion 1,160 \$19,118,500

Work reported during December for the first time as contemplated totalled \$13,997,800. The figures for the Dominion are as follows:

	No. Projects	Value
Ontario	251	\$8,790,700
Quebec	265	2,627,000
Western Provinces	51	2,124,100
Maritime Provinces	16	456,000

Total for Dominion 583 \$13,997,800

The value of construction contracts awarded throughout Canada during 1921 was \$240,133,300, compared with \$255,605,500 in 1920; \$190,028,300 in 1919, and \$99,842,100 in 1918. However, if price recessions in material and labor costs are taken into consideration, the volume of new construction undertaken during 1921 was many millions of dollars greater than the 1920 total.

Canada has undoubtedly passed the worst stages of depression and is now on the up-grade. Activities in the construction industry are sign-posts of conditions throughout the country. During the last four months this industry has revealed extremely encouraging indications. Knowing that the costs of building at the present time have been considerably reduced, those who have for some months intended building are asking for new tenders on their proposed work. Building contractors and builders' supply people are making a special effort to reduce prices to a minimum, to restore this important key industry to its pre-war proportions.

TESTS ON CARBONIZING IRISH PEAT

TECHNICAL Paper, No. 4, issued by the Fuel Research Board, London, England, gives the results of two tests on the carbonization of Irish peat carried out at the Fuel Research Station in vertical gas retorts with steaming. It is stated that the peat, after suitable treatment, lends itself admirably to carbonization both in vertical retorts at temperatures between 750 and 850 deg. C., and in steel retorts at 550 deg. to 660 deg., and that the resulting charcoal is an ideal fuel for suction gas producers.

The peat was macerated, spread on the bog, air-dried, and harvested at Turraun in 1920, and early in 1921 100 tons of it were delivered at the Fuel Research station, in the form of hard blocks about 10 in. long with a cross-section about 2 in. square. Their density was rather under 1, or about twice that of the ordinary hand-cut sods made on the same bog. They could be sawn and cut like hard wood, and had stood transport with very little breaking up into "smalls." On arrival they had a water content of about 25 per cent., but by the date of the tests this had been reduced by storage under cover to 17 per cent.

Conditions of Carbonization

For the most part the peat was prepared for carbonization by passing it through a coal crusher. Quantities of light dust were thus formed, and were not separated but were passed into the retorts. This dust gave trouble owing to its being carried forward by the rush of gas into the gas main, where it formed a thick mass with the tar, and on one occasion caused a serious blockage. The first test, which was carried out at a temperature of 1,000 deg. C., lasted 18 hours, and 11.01 tons of peat were carbonized, all four retorts of the setting being used. A throughput of three tons per retort per day was aimed at, and the quantity of steam supplied to the base of the retorts was sufficient merely to quench the coke before it was extracted. For this purpose six per cent. of steam by weight of the coke carbonized was found to suffice. Under these conditions the volume of gas passing away from the top of the retorts was very great, so that a positive pressure in the retorts and mains was avoided only with difficulty. In the second test, which was made at 800 deg.-900 deg., and lasted 52 hours, 12.39 tons of peat were carbonized, but only two retorts were used, so that the strain on the exhausting arrangements was lessened.

The coke or charcoal came out in very much the same form as that in which the peat entered the retorts but greatly reduced in volume. Its weight was 27 per cent. of the peat as charged, and its ash content was nearly 10 per cent. The amount of dust in it was not excessive. As discharged it had a calorific value of 11,380 B. Th. U. per lb. in the first test and 12,210 B. Th. U. in the second, the corresponding figures dry being 12,560 and 12,650 B. Th. U.

In the first test the yield of gas was 14,900 cu. ft. per ton of peat, with a gross calorific value of 325 B. Th. U. per ft.; in the second, 13,760 cu. ft., with a calorific value of 340 B. Th. U. Owing to its high content of carbon dioxide (about 9 per cent.) the gas was very dense, but it burnt with a satisfactory flame, though with only slight luminosity. It gave out a heavy sickly odor on combustion. An attempt to scrub out the condensable gases was rendered rather difficult by the high carbon dioxide content, but a quantity of light spirit was collected in this way, equal to one gallon per 7,000 cu. ft. of gas, or nearly two gallons per ton of peat.

Tar and Liquor

The condensing and separating arrangements intended for coal tar and liquor were found unsuitable for the peat tar and liquor, and the peat tar being lighter than the peat liquor, special arrangements had to be made for collecting it. The gas and vapor entered the water-cooled condenser at 80 deg. C. In order to prevent an unmanageable quantity of tar and liquor from going forward with the gases it was necessary to reduce this temperature on leaving the condenser to about 20 deg. C. This was well below the

settling point of the tar (40 deg.), so that the liquid issued from the condenser in the form of a yellow emulsion. This had again to be heated up to about 50 deg. in order to obtain separation into peat tar (a black oily liquid) and liquor. On cooling to atmospheric temperature the tar set into a black semi-solid mass showing crystals of paraffin wax.

The volume of liquor collected per ton of peat carbonized was large, and therefore low in ammonia content as compared with normal gas liquor. In color it was a clear bright yellow, becoming dark reddish after standing for 10 litres of the liquor, first in acid solution and finally over some time. By continued fractional distillation of about lime, a small quantity of spirituous liquid was obtained, having a specific gravity of 0.812 and containing chiefly methyl alcohol and acetone.

The peat tar was fractionated in the usual way from a half-gallon iron still, and the fractions 0-170 deg. C., 170-230 deg., 230-270 deg., 270-310 deg., and above 310 deg., refined separately. The last two fractions, which were practically solid at 10 deg., contained almost all the wax, only a small percentage remaining in the pitch. A separate portion of the tar was subjected to steam distillation, and a yield of light spirits (unrefined) was obtained equivalent to 5.2 gallons of 0.866 specific gravity per 100 gallons of tar. This spirit, after refining and distilling to 170 deg., gave a purified spirit equal to 32.5 per cent. of the original distillate. This is equivalent to 1.7 gallon of purified spirit per 100 gallons of tar, or 0.36 gallon per ton of peat carbonized. The remainder of the steam distillate on refining gave a further 0.7 gallon per 100 gallons of tar and distilled up to 210 deg.

Yields Per Ton of Peat

The following table shows the various yields per ton of peat as charged:

	Test No.	
	1	2
Coke		
Cwt.	5.38	5.40
Gas		
Cubic feet at 30 deg. F. and 30 in.	14,900	13,760
Therms	48.4	46.8
Tar		
Gallons (dry)	12.6	21.3
Refined spirit (gallons) ...	—	0.36
Oils (gallons)	7.8	15.1
Paraffin wax (lb.)	8.2	13.7
Pitch (lb.)	43.4	53.7
Liquor		
Total gallons	95.5	87.5
Ammonium sulphate (lb.)	29.2	24.8
Methyl alcohol (lb.)	1.53	1.44
Acetone (lb.)	—	1.14
Acetic acid (lb.)	8.35	7.49

The retorts were heated quite satisfactorily by a portion of the peat gas made during the tests, the amount required being about a third of the total or 3,480 cubic feet per hour in the first test. Therefore on a throughput of 3 tons per retort per day it will be seen that after supplying sufficient heat for carbonizing the peat there remained for disposal from each ton of peat 26 therms (7,940 cu. ft. of gas of 325 B.Th.U.), 12.6 gallons of tar, 95½ gallons of liquor of 3.6 oz. strength per ton, and 5.4 cwt. of charcoal.

R. O. Wynne-Roberts of Frank Barber & Associates, Toronto, and sewage engineer of York Township, stated at a meeting of ratepayers held in Todmorden on January 10, that Toronto is in a position to take care of the York Township sewage but that they cannot turn the storm sewers into the city pipes or it would flood the precipitating tanks of the city. He said that the city was considering a plan to handle this difficulty, and as soon as they made their plans known the township would be in a position to make them a proposition.

FACTORS DETERMINING THE SELECTION OF PAVEMENTS FOR STREETS

Character of Traffic Must Be Considered and Also Climatic Conditions. City Pavements Must Be Durable And Easily Repaired

By C. M. Pinckney

Chief Engineer Dept. Public Works, Borough of Manhattan

THE first factor and the most important in my opinion, is a thorough and complete study of the use to which the pavement is to be put. A traffic census should be taken to determine the volume, density, character and speed of the traffic. The distribution of the traffic is also an important matter. The division of the traffic into motor and horse drawn vehicles; what percentage is on steel tires; the percentage on rubber tires; the percentage of pleasure vehicles and percentage of business vehicles, are all factors which enter into the selection of a type of pavement. If there is a great deal of parking of vehicles on a street this also has a bearing upon the type of pavement to be selected.

Grades of Streets

The next factor to be considered is the grade of the street. Streets with heavy or steep grades can never become main arteries of travel. The traffic conditions thereon, however, can be materially improved by the selection of a proper type of pavement. For instance: When a grade exceeds 5% a very careful study must be made of the character of traffic using the street so as to provide proper traction. It is a good policy to restrict the use of smooth pavements such as asphalt and wood block to grades of 5% or less. We have asphalt pavements, however, on grades as high as 7% and they are giving satisfaction. No city street should be constructed to a grade above 10%.

In connection with the selection of a type of pavement for a street where the grade is involved, consideration should be given to the question of skidding. If the traffic on the city streets is to move without interruption a non-skid pavement should be provided.

Climatic Conditions

The climatic conditions obtaining in a city should be borne in mind when selecting types of pavements also. In a city where severe winters are encountered pavements should be laid which will permit readily of the removal of snow, which will not be affected by cold, and which will not be unusually slippery when the temperature is low.

Noise on Streets

In selecting a type of pavement for a street upon which there are schools, churches, hospitals, dwellings and offices, noise is a most important factor, and quiet must be provided. Where manufacturing and industrial establishments are situated the noise element is not such a great factor. Quiet streets, so constructed that they will assure maximum comfort to brain toilers, are essential in a large city. Noise interferes with the health of persons who work with their brains, and it interferes also with the health of persons who, having worked all day with their brains, must sleep at night.

The zoning of cities into residence and business use aids the engineer very materially in the selection of pavements by insuring the character of the occupancy of the abutting property as well as the use of the street. The business interests in large cities have a tendency to concentrate into districts. For instance, in New York City in the Borough of Manhattan, the insurance district, the financial district and the dry goods district can all be clearly traced, and the produce, butter and eggs, silks, woolsens, cottons and yarn industries can be traced into districts. This helps materially in the selection of a proper type of pavement.

Durability of Pavement

A pavement in a city, in order to be satisfactory must be durable. It must be durable because the repaving of a street seriously interferes with business, interrupts traffic,

and produces general inconvenience. Therefore, the more durable the pavement the less interruption to business, etc. In addition to being durable, a city pavement must be easily repaired; that is to say, it must be possible to effect a quick and prompt repair, and one which will blend in harmoniously with the original pavement and be satisfactory in every way. The pavement which is not readily repaired, or a repair which has to be barricaded over any length of time, is not suitable for a city pavement.

Sanitary Problem

Pavements which are porous or which are composed of materials which are apt to rot or disintegrate under city traffic, are not sanitary. The pavement with open joints is not suitable for use in the city also because of its unsanitary features.

Cost of Pavements

In a large city, it is my opinion that the first cost of the pavement is not the determining factor. Where, however, there are several types of pavement from which to make a selection wherein all of the other factors are equal, the cost then might be made the determining factor. The writer believes, however, that the use of local materials in so far as it is possible should be taken advantage of. Paper read before the City Paving Conference, Philadelphia, Oct. 20-21, 1921.

STRUCTURAL STEEL FOR BUILDING WORK

CANADIAN Allis-Chalmers Ltd., Toronto, have supplied "The Canadian Engineer" with the following prices of structural steel for building work.

"The reduction in steel prices during 1921, has been so marked that we make the following comparison for shapes and plates, f.o.b. Toronto, as "Warehouse" material.

	Shapes	Plates
Dec. 1920	\$4.70	\$4.80 per 100 lbs.
Feb. 1921	4.40	4.50 per 100 lbs.
Apr. 1921	4.10	4.10 per 100 lbs.
July 1921	3.80	3.80 per 100 lbs.
Dec. 1921	3.35	3.35 per 100 lbs.
Jan. 1922	3.00	3.00 per 100 lbs.

The above prices, for plain sections, include exchange, customs and freight, i.e., f.o.b. Toronto.

Mill base prices are now 24% higher than in 1914, while labor is over 70% higher than 1913 for steel production. From this we assume that present selling prices are at "rock bottom" and unless the curve lines representing cost at mill and labor for same soon have a closer relation, a small increase is more likely in the selling price than a lower rate.

Our total reduction in 1921 was about \$34.00 per ton. Lower exchange and freight may still be effective."

SOCKETS FOR TELEGRAPH POSTS

WITH the object of prolonging the life of timber posts such as are used for telegraph, telephone, and electric power cables, an ingenious type of reinforced concrete socket has been introduced in France. The socket is constituted by four vertical members, of which the lower part is inserted in the ground to a depth of from 2 ft. 9 in. to 3 ft. 9 in., and the upper part, projecting to a height of from 3 ft. to 4 ft., constitutes a support for the base of the timber post. The latter is kept at a height of 12 in. above ground level, and in consequence is completely exposed to the air. The vertical members are connected at each end by a circular plate and at the middle by an octagonal base, which is at ground level when the socket is in position. The upper plate is formed with a hole corresponding in diameter to that of the post to be inserted, the lower end of the post being tapered to fit a conical hole in a ring moulded above the octagonal base plate. In addition to its employment as a means of prolonging the life of new posts, the socket can be applied for the utilization of old posts, which have been removed prematurely owing to decay of the part embedded in damp soil.

HIGHWAY DEVELOPMENT IN ONTARIO

Minister of Highways and Chief Engineer Explain Policy and Methods of Construction Followed on Provincial System

SPEAKING before the Toronto branch of the Engineering Institute of Canada, on Jan. 12th, Hon. F. C. Biggs, Minister of Public Works and Highways of Ontario, and George Hogarth, Chief Engineer of Highways, outlined the policy of road development and the methods of highway construction being followed on the provincial system.

Hon. Mr. Biggs, in introducing the subject, stated that until a few years ago, the general standard of highways in Ontario was far below that which should obtain in an old and progressive province. Every effort is now being made, with the assistance of a staff of over 50 engineers, to raise the standard to a satisfactory level.

The speaker traced the growth of the good roads sentiment in Ontario. With the passage of the Highway Improvement Act, some 20 years ago, a systematic plan of education was adopted to encourage municipalities to take advantage of the aid offered. In many instances good roads by-laws were voted down and public officials had to renew their educational work. Last year the county of Peterborough, the last county in Ontario to do so, came into the scheme.

Effort is being made, said Hon. Mr. Biggs, to reconstruct important roads to carry the heavier and more exacting traffic brought about with the advent of the motor vehicle. The first care should be the drainage and sub base, but the public, impatient for a hard surface to travel upon, is disposed to abuse the highway officials until it gets it. In the reconstruction, dangerous curves are being eliminated, and standard grades adopted. There are now about 100 miles of highway on the provincial system that are nearly to the stage of hard surfacing, or to the point where those in charge will get credit for their work. In 1921, about 75 miles of road, on more than twice the length of the Toronto-Hamilton highway, which took 7 or 8 years to build, were constructed. The Minister expressed the hope that still more would be built in 1922.

In this work, said Hon. Mr. Biggs, the engineer was needed from the layout of the road to its completion. Only first-class engineers should be employed, and he was glad to say that in 1920, due to his action, it had been enacted that county road superintendents should be graduate engineers. In the provincial organization responsible for over 1800 miles of roads, there is a minister, a deputy-minister, a chief engineer, and three district engineers in charge of the districts of Eastern Ontario, Central Ontario and Western Ontario. A resident engineer is responsible for 80 to 90 miles of road. The speaker warmly commended the engineering staff for its tact and efficiency in dealing with the difficult situations that constantly were arising in the work.

Some new questions now pressing for consideration were the protection of railway crossings by grade separation and the carriage of lights on all vehicles. The speaker thought a law requiring the latter throughout Ontario might be necessary.

Hon. Mr. Biggs then discussed the possibility of highway improvement in the Toronto district and around other populous centres in the province. He pointed out that great loss and inconvenience arose through having to force products on the market too early in order to avoid the muddy season. He looked forward to the time when Niagara fruit would be laid down by motor in Toronto the morning after it was picked. Such a development would be profitable both to the producer and the consumer. He regarded the motor vehicle as having an economic range of 100 miles and the horse-drawn vehicle of only 8 to 10 miles. In the next ten years, said the Minister, freight would be handled very commonly by motor truck over distances of up to 50 or 60 miles.

An important incentive to the improvement of highways was the tourist traffic, according to the speaker. Last

year the fifth largest source of income in the province was this traffic.

Mr. Hogarth, following Hon. Mr. Biggs, described in a very effective manner, with the aid of a fine collection of lantern slides, the engineering and constructional features of the work done by the Highways Department.

Previous to the meeting, Hon. Mr. Biggs, W. A. McLean, Deputy-Minister of Highways and Mr. Hogarth were entertained at dinner by the executive of the branch.

TOWN PLANNING COURSE STARTS AT UNIVERSITY

SIX municipalities outside Toronto are represented in the membership of the new extension course in civics and town-planning, which opened on Jan. 9 at the University of Toronto. These are New Liskeard, Oshawa, Galt, Hamilton, Port Colborne and Brantford. The majority of those registered, however, are architects and civil engineers from Toronto. The number enrolled on the first day was 41, but it is expected that more will arrive within the next few days.

While registration was in progress General Mitchell, Dean of the Faculty of Applied Science; Prof. Adrian Berrington, of the Department of Architecture; W. J. Dunlop, Director of Extension, and others, met the members of the class informally.

The course began with an address of welcome by Sir Robert Falconer, who said that it had been felt for some time that the university should do something in the way of fostering the study of town-planning.

"In this young country," he pointed out, "there is still time to arrange our towns and cities so that they will be at once useful and beautiful."

Speaking of the case of Toronto, where it seemed almost too late to do as much as should be done, he said that improvements are being made and will be made. He drew attention to the way Halifax had been planned since the explosion disaster.

In closing, he bade them a most hearty welcome to the university, and expressed the hope that they would have a very pleasant and profitable time for the next two weeks.

The Chairman, Prof. Berrington, then called on Dean Mitchell, who said that, while this course had been initiated by Prof. Berrington, he thought the idea had really originated with Sir Robert Falconer some years ago, when he expressed to him his wish that the Faculty of Applied Science might do something along this line. The Dean then discussed the reasons underlying the growth of various Ontario cities and towns, comparing them with the cities of Europe.

Prof. C. H. C. Wright of the Department of Architecture welcomed the class on behalf of his department, and expressed the hope that the course would be the beginning of a series of annual courses of this kind.

The real work of the course began with a lecture on "Maps and Plans," by Prof. W. M. Treadgold of the Department of Surveying. A. H. Chapman, of Toronto, also spoke on architectural treatment. This was followed by a second lecture on maps and plans, the final hour being given over to question and discussions, under the supervision of Prof. Berrington.

TOWN PLANNERS HEAR SCHEME FOR CENTRAL DEPOT

THAT the most important factor in determining the future development of the city plan of Toronto is the location of the railroads and their terminals, which, if they were situated where the present C.N.R. North Toronto line is, would be more convenient to the citizens, and would permit of the development of a park waterfront with an uninterrupted view of the bay and island, was the view expressed by J. P. Hynes, President of the Ontario Town-planning and Housing Association, speaking on the future of Toronto before the members of the short course in civics and town-planning at the University of Toronto on Jan. 10.

"Toronto gives evidence of tending to expand fairly evenly in all available directions, now that the natural barriers are being overcome by such means as the Bloor street viaduct and the natural and artificial ones by the consolidation of the street car system.

"A particular tendency of the development is for the Wells Hill elevation and the C.P.R. track between it to develop a line of demarcation between the business and industrial city on the south and the residential city on the north. Therefore, if the North Toronto C.P.R. line be developed as the transportation backbone of the city, very orderly town-planning may be obtained, quite in keeping with the trend of the present development of the city.

Mr. Hynes then went on to explain the workings of such an arrangement of the railroad lines, choosing the site of the central union depot between Yonge street and Avenue road, and supplementing it by sub-stations along the line. Streets running north and south would pass over the railway development without interruption, lessening rather than exaggerating the present objectionable grade.

"The development of this traffic backbone between the industrial and residential city would overcome the necessity of the proposed viaduct across the waterfront, and permit of it being developed into what should be Toronto's outstanding attraction, a park waterfront.

Speaking on transportation within the city, A. E. K. Bunnell, Engineer to the Toronto Transportation Commission, said that the growth of the city was not north and south, but east and west, and that the big movement of traffic was east and west.

"Bloor street," he continued, "is the strategic position to serve traffic. It is bound to be a business street, and if we do not widen it now stores will spring up to prevent us in the future.

"We have got to put the Bloor street widening through this year, even if we do nothing else in the way of improvement," he declared.

INTERNATIONAL JOINT COMMISSION RECOMMENDS 30-FT. CHANNEL

IMPROVEMENT of the new Welland Canal between Lake Erie and Lake Ontario, as well as the St. Lawrence River, to provide a 30-ft. channel from Lake Erie to the sea, has been recommended by the International Joint Commission in its report on the proposed Great Lakes-St. Lawrence waterway, according to Representative W. W. Chalmers, Republican, of Ohio.

Mr. Chalmers, on Jan. 11, introduced a bill in the House authorizing the improvement on the part of the United States, but stipulating that the expense be borne equally by the United States and Canada, through a bond issued, guaranteed by both governments.

The report of the commission, which has been submitted to the State Department, but has not yet been made public, Mr. Chalmers said in a statement, recommends that the project, including the widening and deepening of the new Welland Canal, be undertaken, and that the cost be met through taxation by the United States and Canada, in proportion to the benefits derived.

The commission's report, Mr. Chalmers said, recommends that the division of costs be figured on the basis of known traffic for the past five years, to be definitely ascertained by an international survey.

"I believe such a procedure is too indefinite and intangible to be used as a basis for determining the allocation of the costs of the enterprise which will run into the hundreds of millions of dollars." Mr. Chalmers declared that "each country should pay an equal amount."

The Chalmers bill provides that bonds issued for the Government should be retired with proceeds derived from the sale of hydro-electric power made available for commercial use by the improvement. The measure also provides that the benefit derived in the way of hydro-electric energy shall be evenly divided between the two countries.

Jurisdiction over construction and operation of the entire waterway under the Chalmers bill would be in the

hands of an international board of six members. Three representing the United States and three Great Britain. The board would have authority to sell hydro-electric power and to issue bonds for the improvements.

AVOID TOWN PLANNING MISTAKES OF TORONTO

EVEN small communities should begin to plan for the growth which will inevitably come instead of allowing it to take its own haphazard course, was the idea that Prof. C. H. C. Wright, head of the Department of Architecture, University of Toronto, gave in a lecture to the students of the short course in town-planning on Jan. 11.

"The small community is the seed of the big town," he said, "and if we can start the sapling growing right, the big tree will grow right, too.

"But, if by reasons of survey, by ignoring the topography of the land, by individual caprice, we allow the sapling to grow up wrong, we will not be able to do anything with the tree.

"Toronto began on the low land, following the concession lines along Yonge street until those lines became solid with buildings. Instead of having a city on a fine site, it tries to extend and grow as though that site had no other qualities than that of a flat plane. Ravines, instead of being emphasized and exaggerated as magnificent winding parkways, are, wherever possible, ignored. We take our roads up the hill in most cases at the steepest possible grade.

"Exactly the same absence of thought and prevision are to be found in the places that consist of one grocery, a few shacks, possibly a meeting house and a school. These places, chiefly by reason of their varying topographical conditions, have each a character of their own.

"The proper idea for every place might be roughly defined to be as different from the places around as possible. Then every settlement, no matter how small, will be able to boast that in some respect or respects it is better than any other place."

ONTARIO LEADS IN TOWN PLANNING

SPEAKING on the results of the Federal Housing Loan in the Dominion before the members of the Short Course in Town-planning at the University of Toronto on Jan. 12, W. D. Cromarty of Ottawa stated that Ontario had availed itself of the loan to a far greater extent than any other province, and that, on the whole, the efforts of the various Ontario municipalities had met with success. He showed many pleasing examples of modest house building in various parts of the province, together with one or two American examples and said that Canadian endeavors were, on the whole, superior.

Mr. Govan of the Parliament Buildings, well known in housing circles, said that he was pleased to see that on the program the word Ontario had been stressed, because our ideals in small houses were apt to be turned by the influence of American journals toward houses suitable to Florida and California, but totally inappropriate to a province that has to consider its coal bill for six or eight months in the year.

He pointed out that by proper attention to maximum exposure to the south, together with the employment of insulating devices and materials for the walls the coal consumption of every six-room house in the province might be reduced by two tons.

J. B. O'Brien explained how many difficulties even under existing imperfect legislation might be overcome by a body of citizens really determined to better their city.

H. L. Seymour continued the subject of zoning, which means the sorting out of a city so that each part of it is assigned to and designed for certain definite functions. Under this system there would be more or less defined business areas, factory areas, residential areas of various types, etc.

Prof. W. M. Treadgold exhibited motion pictures showing the actual processes of modern road building.

LETTER TO THE EDITOR

Sir: I beg to acknowledge receipt of your card of January 4, calling my attention to an item appearing on page 4 of the issue of "The Canadian Engineer" for December 29, 1921. I would like to have this item corrected, because, as it stands at present, it gives a wrong impression.

My proposal to the city of Brandon is that, if the commission undertakes to supply power to the said city, by means of a transmission line from Winnipeg to Brandon, at a total expenditure (including terminals) of about \$1,200,000, the following conditions would rule:

The city of Brandon to guarantee to the Manitoba Power Commission the fixed charges plus the actual cost of the power for any amount used.

Basing the rates on the figure given and with the conditions as stated, the actual cost to the city of Brandon would be as follows:

Consumption of 3,000,000 k.w.h. per year, the	
cost per k.w.h. would be	6.5 cents
Consumption of 4,000,000 k.w.h. per year, the	
cost per k.w.h. would be	4.7 cents
Consumption of 5,000,000 k.w.h. per year, the	
cost per k.w.h. would be	3.85 cents

Taking either first, second or third schedule, the return, at the price stated, would cover the fixed charges for the full year of operation, and any amount over that scheduled would be taken at actual cost of power. As a consequence, the power consumed, above the stated amount, would cost the city of Brandon in the neighborhood of 1c per kilowatt hour, thus permitting the city to sell power at a very low rate, after having fixed a rate for lighting purposes that, as proposed, could be set at between 6c and 7c.

At the present time the actual consumption by the city of Brandon is somewhere about 4,350,000 k.w.h. per year, at 12c per k.w.h., and there is no doubt that with the reduction in rates this consumption would be doubled by the end of the first year, and that the load would increase from year to year.

You will see, therefore, that the item referred to does not give an accurate idea of the situation or my proposition, and I would like, if it could be managed without undue convenience to you, that the said item be corrected in accordance with the figures given herein.

I remain,

Yours very truly,

T. ROCCHETTI,
Acting Commissioner.

Winnipeg, Jan. 7, 1922.

Sir: In response to your request that I would forward you a paper containing some impressions of my inspections of Canadian and United States Roads, I have pleasure in submitting the following:

Dealing first with Canadian roads, the foremost impression was as to the magnitude of the task of providing hard roads for so huge a country, and the second was the thorough way in which the task is being undertaken, and the third, the high standard of construction you have set yourselves to accomplish. If this standard can be pursued you should in a few years have a system of roads second to none.

The widths to which construction is being carried seemed to me likely to prove inadequate in the near future, but I realize with so lengthy a mileage it is most desirable to get a good surface on as much as is practicable at the earliest possible moments leaving widening to a time when development justifies an even larger expenditure and more adequate funds will possibly be available. I can conceive that good roads will immensely hasten development of your country and expenditures on roads will reap an ample harvest in improved values. No country can be exploited to full advantage until it has good road communications.

I was struck with your fine cities of Montreal, Ottawa and Toronto, and the wisdom displayed in getting main arteries of good width and direction. It is such a contrast to the conditions here, where the slow and unregulated growth of centuries has tended to cramp all our towns. You have had your opportunity, and learned your lesson in good time, so that the congested parts of your cities are confined to a very small area.

I found the same general conditions throughout my tour through the eastern part of the United States. Speaking quite generally your problems impressed me as being very similar and your road practice proceeds on almost identical lines. One problem I think you both have to solve is that of diagonal communications. Your layout, being rectangular as a guiding principle seems to me to need diagonals. Admittedly it cuts up land awkwardly, but the advantages in the way of communication I think outweighs other considerations.

Your concrete roads impressed me as affording good service in your present stage of development, and with proper maintenance, should give a good life. Your traffic being mainly rubber tired and in comparatively light units affords them a much better chance than in this country. Here our traffic units are in every class much heavier, comprise a large proportion of steel tires even on heavy steam vehicles, and we have as many vehicles with a registered unladen weight exceeding 2 tons as we have in the category of under 2 tons.

The asphalt roads of the cities I thought were extremely good and less wavy than ours, due partly I think to the lighter units of traffic, but also to the greater experience your engineers have had in the use of this material, which has only been developed here on a considerable scale in quite recent years, largely no doubt owing to heavy freight charges on bitumen.

Both Canadian and American engineers have advantages over us in the superiority of their technical and scientific training supplied by your universities. We are extremely backward in that respect, inasmuch as few of our universities have an engineering side, and none has yet a chair of highway engineers. I have returned to the old country with a very high opinion of the equipment of your engineers for the beneficent work they have to perform in the development of your huge country, a great admiration for the way in which they are performing that function, and with grateful remembrance of the kindly hospitality and assistance extended to me by every engineer it was my good fortune to meet on my tour.

Yours faithfully,

ALFRED DRYLAND, M. Inst., C.E.,
County Engineer of Middlesex.
Kingston-on-Thames, Dec. 18, 1921.

Prof. C. R. Young, assistant professor of structural engineering, University of Toronto, gave an illustrated lecture to members of the Hamilton branch of the Engineering Institute of Canada on the Detroit River bridge, on Jan. 13. He is a member of the board of engineers appointed to supervise the construction of the bridge. Mr. Young gave an interesting talk on the great feat of erecting the big bridge, and with slides showed the work from start to finish. The address was one of the most educational and interesting heard by the members. The work of construction will be supervised by an international board of engineers. Canada is represented by C. N. Monsarrat and C. R. Young, who are well known authorities on bridge construction in the Dominion.

At a luncheon of the Quebec Branch of the Engineering Institute of Canada, held at the Chateau Frontenac, Quebec, on January 9, O. H. Cote, Industrial Commissioner for the Board of Trade, gave an address on "The Ship-building Industry at Quebec in the last century." Mr. Cote said that construction of wooden ships was for a number of years the principal industry in Quebec but now it exists no longer.

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LIFE OF WIRE BRIDGE CABLES

Satisfying assurance of the permanence of the three great suspension bridges across the East river at New York has been received recently as a result of a careful examination of those portions of these structures most frequently criticised, namely, the cables. Brought about by the necessity of removing the fabric wrapping of the Williamsburg bridge cables and replacing it by a wire wrapping of the same character as used for the Brooklyn and Manhattan bridges, a careful investigation of the condition of the wires under the wrapping of the cables for this bridge as well as for the other two was made by the Department of Plant and Structures of New York City. As interested parties, representatives of the engineering staff of the Philadelphia-Camden bridge made an inspection of the condition of the cables of the three bridges at the same time, and as a result of the conditions found, have indicated their confidence in the type of structure proposed at Philadelphia.

The indication thus obtained of the long life of wire bridge cables properly protected is merely one of many that have been available to the engineering profession for a long time. The 1010-ft. wire cable suspension bridge built across the Ohio river at Wheeling, West Virginia, in 1846 by Charles Ellet and later reconstructed by John A. Roebling, contains, for the most part the original cable material. After a use of 76 years this material is said to be in perfectly good condition. The Cincinnati and Covington bridge, constructed originally with two iron wire cables, and opened for traffic in 1867, still contains these original cables in excellent condition. When the Roebling railway suspension bridge was built across the Niagara river in 1855, use was made of the cable wire that had formed a part of the original Ellet structure built in 1848. Except for the necessity of cutting out a few dozen wires which

had been badly exposed, the cables so constructed continued to do service till 1897 when the bridge was replaced by the present railway arch. The excellent resistance of cable wire to corrosion was also evidenced when the present Lewiston-Queenston suspension bridge was built in 1899. On removing the old cables of the former structure, which had been built in 1851, they were found to be in an excellent state of preservation. In the new structure, cable wire which had been used in the upper suspension bridge at Niagara Falls, as reconstructed in 1889, was used.

In all the suspension structures built in America prior to about 1880 a clean, bright wire was used, usually dipped twice in boiled linseed oil, passed through an oiled sheepskin, on being unrolled from the reels prior to stringing and then carefully oiled in the strands before the wrapping was applied. With the construction of the Brooklyn bridge, however, from 1876 to 1883, advantage was taken of the newly established art of galvanizing. Both the strand wire and the wrapping wire were treated by the new process with results that have been shown to be excellent. Examination has shown that the Brooklyn bridge cables are as good as they ever were.

Believing that the experience with suspension bridges built prior to 1880 indicated a practically unlimited life for bright wire properly oiled, the engineers of the Williamsburg bridge decided to protect the cables by filling the spaces between the wires with "slushing oil," a hydrocarbon, to which was added 25% of artificial graphite. Instead of covering the entire cable with wrapping wire, as had been done in the Brooklyn bridge, it was covered with four wrappings of canvas, heavily coated with the same bituminous material as filled the interspaces between the wires. To make the whole entirely waterproof and to protect it from the atmosphere, a 1/16-in. steel sheathing was placed outside the fabric. The experience of twenty years has shown, however, that this method of protection is inferior to that adopted by Roebling. The metal sheathing corroded and the canvas wrapping had hardened so that the motion in the neighborhood of the suspenders had caused it to break destroying the waterproof seal at these places. Fear of dangerous corrosion prompted the Department of Plant and Structures to remove the faulty covering and wrap the cables throughout with No. 9 Norway iron galvanized wire. With this protection, there is no doubt the life of the Williamsburg cables will be practically unlimited.

In the construction of the Manhattan bridge, completed in 1909, the Roebling method of cable protection was followed, although at that time there was no indication that the protective covering on the Williamsburg bridge cables would not be satisfactory. The farsightedness of the engineering staff in charge of bridge work in New York City at that time has been amply demonstrated in the excellent condition now found in the Manhattan cables.

It thus appears, as a result of an experience with wire cables in this country extending over a period of about three-quarters of a century, that even with the methods of protection devised for wire cables forty-five years ago, there should be no doubt whatever so far as the cables are concerned, of the life and serviceability of the wire cable suspension bridge for centuries.

RAILWAY POLICY IN THE MAKING

Now that the leader of an important political party in Canada has demanded the immediate consolidation of the Grand Trunk Railway with the Canadian National System and a substantial reduction in freight rates, the announcement of a definite railway policy by the government may be expected shortly. In the adoption of such a policy great issues are at stake. A decision must be made between the consolidation urged by one group and the Shaughnessy plan advanced by another. It is a question of carrying the public ownership idea to its logical conclusion, or returning

the Grand Trunk to its owners and merging the National System with the C.P.R. That the problem cannot be solved on the broad question of idealistic preference without regard to details is evident from a very slight consideration of the matter. Thus, the possible refusal of the United States to permit a foreign government to own and operate railways within its borders has a bearing on the disposal of the Grand Trunk that might well fix the whole policy of the government in railway matters.

PERSONALS

SENATOR HEWITT W. BOSTOCK, M.A., of Kamloops,



B. C., the new Minister of Public Works, was born in Walton Heath, Surrey, Eng., May 31, 1864, and was educated by private tutors and at Trinity College, Cambridge. In 1888 Mr. Bostock was called to the Bar at Lincoln's Inn but never practiced; went to British Columbia in 1893 and engaged in ranching, fruit growing and other interests. The new Minister was elected to the House of Commons for Yale-Cariboo in 1896 and was appointed to the Senate on June 6, 1904. He is a Fellow of the Royal Agricultural Society. He was President of the Interior Stock Raisers' Association of British Columbia in 1916.

ALBERT ROBERTS has been re-elected chairman of the Water Commission, of St. Thomas, Ont.

GEORGE A. GOODMAN, contractor of Windsor, Ont., has been elected president of the Builders and Contractors Association of Essex County.

J. C. BREITHAUP has been elected chairman of the Kitchener, Ont., Water Commission for the twenty-third consecutive term. He has been chairman ever since the commission was first established.

DAVID O. LEWIS, M.E.I.C., has been elected president of the Association of Professional Engineers of the Province of British Columbia for 1922. Mr. Lewis is also a vice-president of the Engineering Institute of Canada.

W. L. McDOUGALD has been appointed chairman of the Montreal Harbor Commission. He assumed his new duties on Jan. 11. The new chairman has been president of the Ogdensburg Coal and Towing Co. for many years.

GORDON D. CONANT has been elected chairman of the Oshawa Board of Water Commissioners for 1922. The new chairman is an ex-mayor and has also served on the Commission for some time.

PROF. C. R. YOUNG, member of the Advisory Board of Consulting Engineers for the Detroit-Windsor bridge, addressed the Hamilton Branch of the Engineering Institute of Canada, on Jan. 13, on the engineering features of the project.

OBITUARY

LOUIS B. TURPIN, contractor of Winnipeg, Man., died recently in that city at the King Edward Hospital.

THOMAS R. LABELLE, formerly a builder and contractor, died at his home in Toronto on January 9, aged 64 years. The deceased was born near Colborne, Ont. and had been a resident of Toronto for 38 years.

Condensed Advs.

Advertisements (not displayed) under this heading at following rates per insertion, with sixty-five cents per insertion as minimum rate in any case: "Positions Wanted," two cents per word; all other condensed advertisements, four cents per word. Payable in advance; 50 per cent. extra if charged.

TRANSIT FOR SALE—Six Inch, Dietzgen Transit, nearly new. Can be seen at Art Metropole Ltd., 14 Temperance St., Toronto. —207

CIVIL ENGINEER—26, A.M.A.A. E., six years' experience in surveying, drafting, construction, operation and maintenance of electric railroads, safety engineering and fire prevention. Open for engagement. Box 31, "Canadian Engineer," Toronto.

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PATENT NOTICE: Any one desiring to obtain the invention covered by Canadian Patent No. 198201 granted on 16th March, 1920, to Juan Ismael Domingues, of Buenos Aires, Argentine Republic, for Apparatus for Catching Flies, may do so upon application to the undersigned who are prepared to supply all reasonable demands on the part of the public for the invention and from whom full information may be obtained, Fetherstonhaugh & Co., Ottawa, Russell S. Smart, resident. —208

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The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Construction Industries Conference in Hamilton

Important Report Presented by Labor Committee — National Joint Conference Board Ceases to Function — Basic Principles Adopted — Business Outlook for 1922 Said to be Encouraging — Full Report of Proceedings

THREE outstanding questions formed the chief topics for debate at the fourth annual conference of the Association of Canadian Building and Construction Industries, held last week in the Royal Connaught Hotel, Hamilton, Ont. These questions were:

1. What conditions will prevail throughout the construction industries in Canada during 1922? In other words, Will business be good?

2. Will there be any further reduction in the price of building materials and in the wages paid to labor?

3. Should the construction industries continue to recognize international labor unions, and particularly their paid business agents?

After devoting four days to the study of statistics, the exchange of information and the discussion of basic factors, practically all of the members present agreed that there is every indication and prospect of good business during 1922; not a boom, but good, solid business that will be better than 1921 and will permit most contracting and supply firms to work to 50% greater output than in 1921 and to make a reasonable profit on their turnover.

The questions regarding costs and labor were answered principally by the report of the Labor Committee, which was the most important report presented at the conference, and which consisted of a number of resolutions, as follows:

Report of Labor Committee

"Clause 1 — **BASIC PRINCIPLES** — Resolved that the basic principles herein enunciated should be adopted:

"It is realized to-day by public-spirited employers and workmen that their mutual interests should be considered in a spirit of co-operation. In order to be lasting and beneficial, such co-operation must admit certain fundamental rights of both employers and employed, and be carried out by both in the spirit of fair play.

"Co-operative efforts have been attempted in the building and construction industry of Canada, and, in order that these efforts may be such as are likely to lead to satisfactory results, it is felt that certain principles should be accepted by both employers and employees. The following principles are therefore considered to be of basic importance in these efforts to co-operation in the building and construction industry.

"1—No business can last unless there be a substantial accumulation of reserves in order to provide for expansion, periods of depression, and unfortunate experiences involving loss.

"On the other hand employees are justly entitled to expect a remuneration for their services which is more than sufficient to provide for a mere existence and which will enable them to accumulate a surplus to meet contingencies always provided that efficient services have been rendered.

"2 — In localities where any particular labor organization or organizations are in the ascendancy it is wise and expedient for employers and the employees representing such organization or organizations, to enter into agreements, the objects of which will be to stabilize the industry.

But it must be recognized that every individual should have the unrestricted right to work where and with whom he chooses, irrespective of his affiliations with labor organizations.

"Labor organizations who effect agreements with employers should not endeavor to make use of this relationship to the disadvantage of such employers, in order to wrest advantages from employers who do not make such agreements with labor organizations.

"The combined efforts of both parties should be exerted to increase and stabilize the earning power of both employers and employees.

"4 — There should be no discrimination against either employer or employee in a locality where no trouble exists, because of the collective action of his organization in another locality.

"5 — The best efforts of both employers and employees should be directed to the elimination of jurisdiction disputes.

"6 — The general principles of arbitration should be the basis of settling all disputes. Each party should agree to submit disputes to arbitration and refrain from making use of lock-out or strike until the lapse of a specified period after the recommendation of the Board of Arbitration has been made.

"7 — Special encouragement should be given to Apprenticeship.

"The foregoing principles are those that may be held to apply to existing conditions and any change in these conditions that the future may bring forth may warrant their modification or amendment.

"Clause 2 — **BUSINESS AGENTS** — Resolved that in the common interest of the public, the employee and the employer, the policy of this Association shall be to deal directly with the actual employees rather than with Business Agents.

"Clause 3 — **AGREEMENTS** — Resolved that when any agreements are reached with Labor, that these be reduced to writing and that they should only cover wages and hours of work, having in view the stabilizing of rates, and that the Basic Principles enunciated above should find expression in all such agreements.

"Clause 4 — **WAGES AND RESULTS** — Resolved that the very apparent injustice created by the flat-rate system appears to have no complete solution at this time; but it is recommended that all members of this Association should do everything possible to reward the more efficient men by arranging by transfer, to provide constant employment for these men.

"Clause 5 — **INDUSTRIAL COUNCILS** — Resolved that in our industry we have found Joint Industrial Councils tend only to cause dissension rather than cure it, and therefore, such councils should not be continued.

"Clause 6 — **NATIONAL JOINT CONFERENCE BOARD** — Resolved that until such time as the labor members of this Board can agree to the basic principles adopted at this conference, the activities of the Board shall cease.

"Clause 7 — APPRENTICESHIP — Resolved, whereas the present conditions are not favorable for the training of apprentices in the Construction Industry; and whereas it is realized that a serious shortage of trained artisans in certain trades exist; resolved that the Executive be authorized to take up this question with the Federal Department of Labor in an effort to assist the employees by proper legislation and funds to alleviate this condition.

"Resolved further that the National Apprenticeship system as adopted at the May, 1922, Conference at Ottawa be modified where necessary by the preceding and the following recommendations, and particularly as to age limit, and that it should be used as a basis for action.

"Clause 8 — COSTS — As a preamble to this resolution, the following analysis of the present business situation should be given:

"This Conference realizes that the future horizon is clouded and that prophecies in these days are dangerous. It also realizes that the national prosperity cannot remain much longer in the present state of stagnation; further, that as soon as business from a national standpoint commences to move, just so soon will building work start to move.

"In the Construction Industry there exists a scarcity of mechanics, which scarcity will be accentuated when work becomes plentiful, and which condition will undoubtedly be accompanied by the usual drop in efficiency. At the same time it is realized that certain of the basic materials are at present at an artificially low level, and for all the above reasons building costs will tend to increase. On the other hand there still remains many centres where reasonable reductions in wages have not been put into effect and there still remain many major materials the prices of which have not undergone proper deflation, both of which factors will, when righted, tend to decrease prices.

"The Conference is, therefore, of the opinion that although the general trend of costs will be downward, the movement will be very slow and subject to temporary movements in the other direction."

Resolutions Adopted

All the above resolutions were unanimously adopted at general sessions of the conference. Another important resolution that was adopted without opposition was the following, which was presented by a special committee consisting of three general contractors, three-trade contractors and three supply dealers or manufacturers:

"Resolved that a badge or seal be at once prepared for the common use of all members of the Association, and that the seal be copyrighted.

"That a small charge, the amount of which is left with the Executive, be made for the use of this seal and the necessary die, and that every application for a seal be passed upon by the Executive of the local branch or affiliated body, where such exists, in the applicant's locality, and further that both such Executives must endorse the application before granted.

"That this seal be used on the stationery of the grantee.

"That in granting the right to use this seal, the Executive or Executives should scrutinize carefully the integrity, the ability and the responsibility, financial and otherwise, of the applicant, and that power be given the Executives to withdraw the right to use this seal, for cause.

"That it be established as a guiding principle to the members of this Association, as between section and section, that they recognize this seal by working together toward their common advantage."

Standard Practices and Contracts

Another important report was the following, presented by a committee appointed to deal with the standard and cost-plus contract forms that had been recommended at the conference of the association held last year in Winnipeg:

1 — "STANDARD CONTRACT FORMS — Having gone carefully into the correspondence relating to this form of

contract, which is the result of certain recommendations of your committee at the Winnipeg Conference, when the form was adopted, we find nothing in this correspondence that would justify making any alterations; we would therefore recommend that the executive of this Association at an early date consider ways and means of having these forms printed and distributed to the several exchanges, for the use of its members, and they as members of this Association do all in their power to have these forms of Contract adopted for general use by all architects, engineers and public bodies. Also that an adequate unit price per copy be charged to cover the cost of producing same.

"2 — COST-PLUS CONTRACT FORMS — Your committee would recommend that owing to the heavy expense involved in printing this document, that it be placed at the disposal of the members through their exchanges in such form as the executive may decide, as we are of the opinion it would be a guide to the members entering into this form of contract.

"3 — STANDARD PRACTICES — We feel that we cannot enlarge on the very comprehensive report and recommendations brought in by the special committee at our last conference, unless it be to further strongly recommend that as these standard practices demand to a large extent, as to their adoption and enforcement (if only in spirit) on a spirit of friendliness and good fellowship, that the social side of all local associations and exchange work be given more attention; and as far as possible some form of entertainment should be introduced at least once a month, so as to foster and encourage this friendship and good fellowship to the fullest extent.

New Officers Elected

The report of the nominating committee was received without opposition, and the secretary was instructed to cast one ballot for the election of the following officers, who will form the executive of the association for the ensuing twelve months:

Past President — J. P. Anglin, of the Anglin-Norcross Co., Montreal.

President — J. B. Carswell, Carswell Construction Co., Toronto.

First vice-president — James Mackie, James Mackie Co., Winnipeg.

Second vice-president — John V. Gray, John V. Gray Construction Co., Toronto.

Honorary treasurer — E. G. M. Cape, E. G. M. Cape Co., Montreal.

Honorary secretary — John Grieve, Dominion Paint Works, Montreal.

Member of Executive elected by General Contractors' Section — J. M. Pigott, Pigott-Healy Construction Co., Hamilton.

Member of Executive elected by Trade Contractors' Section — E. G. Brousseau, Brousseau Bros., Quebec.

Member of Executive elected by Supply Section — M. F. Gibson, Interlocking Tile Co., Toronto.

Western members of Executive — F. T. King, British Columbia; Geo. E. Hughes, Alberta; William Wilson, Saskatchewan; H. T. Hazelton, Manitoba.

Attendance Very Satisfactory

The attendance at the conference was considered very satisfactory, although not so large as the importance of the meeting really justified. The registration included 65 representatives of 51 different general contractors, 29 representatives of 27 trade contracting firms, and 95 representatives of 72 different manufacturing firms or supply dealers. Of the total registration of 189 (exclusive of the press), Hamilton lead with 52; Toronto came a close second with 51; Montreal third, with 8. There were 7 representatives from Saskatchewan, 3 from Manitoba, 11 from Quebec (including Montreal), and 5 from the Maritime Provinces. The others came from various cities and towns in Ontario.

All of the general sessions of the conference were held in the ball-room of the Royal Connaught Hotel. A long

the walls of this room booths were arranged to accommodate exhibits of materials by the members of the Supply Section of the association. Similar booths also lined the hallway leading to the ball-room, and an overflow of exhibits was accommodated in the small room adjacent to the ball-room. Among the exhibits were the Steel Co. of Canada, Pedlar People Ltd., Super-Cement (American) Ltd., Crane Ltd., Trussed Concrete Steel Co., Brantford Roofing Co., A. B. Ormsby Co., Burlington Steel Co., Ontario Gypsum Co., Babcock-Wilcox Boiler Co., Frost Steel & Wire Co., Bishopric Mfg. Co., Canada Paint Co., Concrete Pipe & Products Co., Canadian Surety Co., Dominion Paint Works, Austin Mfg. Co., Otis-Fenson Elevator Co., Bird & Son, Bartonville Concrete Products Co., Interlocking Tile Co., Canadian Metal Window & Sheet Products Co., National Fireproofing Co., Interprovincial Brick Co., Hamilton Sand & Gravel Co. and Toronto Brick Co.

Luncheon, Tuesday, January 17

The conference opened on Tuesday morning, January 17, with registration and inspection of exhibits. At 1 o'clock there was a luncheon, at which J. P. Anglin, president of the Association, presided. Mayor Copley, of Hamilton, welcomed the visitors. Among the construction problems in Hamilton, he said, are those relating to sewage disposal, sewers, water works and roads for the districts that are being built up, and which will in the future be built up, in the western section of the city.

Lt.-Col. B. O. Hooper, of the Bank of Hamilton, welcomed the delegates in his capacity as vice-president of the Chamber of Commerce. During the past 18 months, said Col. Hooper, he had built 20 houses in Hamilton and had made a profit on the sale of every one of them. There is money to be made in building at present prices, he declared. The country is sane, and is developing on sound lines, so there is no cause for pessimism. Financially, compared with other nations Canada is in splendid condition.

J. F. Mercer, president of the Hamilton branch of the association, called attention to the increase in building permits in Hamilton, the 10% reduction in wages in July, 1921. He expected no labor trouble this year.

Tuesday Afternoon, January 17

J. P. Anglin presided at the first general session of the conference on Tuesday afternoon. J. Clark Reilly, secretary of the association presented his annual report.

The report of the treasurer was received, showing a balance on hand and in the bank of only \$21.60.

The president appointed the following nominating committee: A. A. McDonald (Halifax), W. J. Crawford (St. John), E. S. Mattice (Montreal), F. A. Magee (Hamilton), Jas. Mackie (Winnipeg) and Geo. H. Whitlock (Moose Jaw).

R. J. Fuller (Toronto) suggested the appointment of a small committee to deal with freight rates as affecting the construction industries. Building materials of the heavier type are subject to high rates, said Mr. Fuller, while certain items such as contractor's plant are charged at entirely unreasonable rates. Mr. Fuller's suggestion was referred to the resolutions committee, with the result that a freight rates committee was later appointed under the chairmanship of F. B. McFarren (Toronto).

J. P. Anglin delivered the annual presidential address. He would not prophesy what the immediate future holds in store for the construction industries, although he was absolutely certain of the ultimate future of Canada. The next quarter century will be Canada's, he declared, but the trouble at present is the world condition rather than any national or local situation. He called attention to the shortage of building mechanics, particularly bricklayers. The speed with which construction work can proceed to-day, he said, is limited by the contractor's capacity to lay brick, and to meet this situation many engineers and contractors are endeavoring in various ways to eliminate brickwork.

Mr. Anglin urged that attention be given to the problem of continuity of employment for building mechanics, and said that it is remarkable that the general public should

turn to the building industry to solve the whole employment situation. Men from factories such as stove and steel works cannot often be used to advantage in construction work, he declared and each industry will have to solve its own employment problems.

The construction industries are gradually being worked into a position where they are dealing entirely with labor unions, said Mr. Anglin, rather than with individual employees or groups of employees. Contractors may soon be called upon to discuss international unions more seriously than ever before, and the subject should be treated very carefully, with justice to all concerned, including the public. And nothing should be done by either employers or employees to discredit the industry in the eyes of the public.

Costs of building materials, said Mr. Anglin, is another subject that the conference should handle without gloves. Buildings are required all over Canada, but owners hesitate to build because they think that costs may be reduced still further. The manufacturers point out that freight, fuel and labor govern costs of most commodities, and that until these three items are reduced, prices of many commodities can go down no lower. Whether this be correct or not, said Mr. Anglin, the aim of every manufacturer connected with the construction industry this year should be to see how much he can contribute to the industry and not how much he can withhold from it.

Contractors should not be secretive in their dealings with each other, he declared. They should not imagine that they have something that other firms have not; in most cases this is not true, and all firms would be further ahead if they would freely exchange information regarding their methods.

James Mackie, of Winnipeg, agreed that a more definite stand be taken against paid labor leaders, or business agents. In the plumbing and heating trade in Winnipeg, the experience had been that the men were not unreasonable when facts were properly presented to them, provided that the men could be reached directly and the path not blocked by business agents whose desire was to safeguard their own jobs rather than to safeguard public interests.

J. E. Carswell, of Toronto, vice-president of the association, reviewed the conference that had been held in May, 1921, at Ottawa under the auspices of the Department of Labor. At that conference a special committee had investigated the question. Are buildings not required or are they delayed owing to high costs? It was found that the accumulated demand for buildings and public works in Canada was at that time probably \$780,000,000. When times become normal, said Mr. Carswell, there will undoubtedly be a great shortage of building mechanics. There would not be half enough bricklayers if times were normal at present, and some scheme for dual training should be perfected, he thought for example, a boilermaker could be taught bricklaying and a bricklayer could be shown how to make boilers.

The May conference, continued Mr. Carswell, had been opposed to unemployment insurance except as a last resort. Joint industrial councils had been approved as beneficial to the construction industries. An analysis of building costs had been made and showed that 80% of the total cost is labor. Other subjects that had been covered in the May conference were efficiency and production, wages and the cost of living, and conciliation and arbitration.

The work of the National Joint Conference Board practically stopped a few days ago, said Mr. Carswell, owing to a failure to agree upon basic principles. The representatives of the employers had frequently requested a statement of the principles upon which international labor unions are based, but had failed to elicit a reply. In an effort to get something definite, the employers had outlined seven suggested principles to govern relations between employers and employees in the construction industries in Canada. These were practically the same as the seven principles included in Clause 1 of the aforementioned Labor Committee's report. After consideration, the labor members of the National Joint Conference Board had countered with the following:

"Agreed to preamble and Principle No. 1. ..

"Wish to substitute the following for Principle No. 2:

"For the successful operation of the building industry in all localities, it is fully recognized as being both wise and expedient, and in the best interests of both employers and employees, that mutual agreements be made governing wages, hours of labor and working conditions.

"Wish to substitute the following for Principle No. 3:

"All agreements entered into between employers and employees should be observed to the fullest extent, both in spirit and letter, and where such agreements exist, all work should be carried on with a view of increasing efficiency, stabilizing the industry and removing all sources of friction.

"Disagree entirely with Principle No. 4.

"Agree to Principle No. 5.

"Wish to substitute the following for principle No. 6:

"The general principles of collective bargaining and direct negotiations between employers and employees, through their respective organizations, shall be the recognized basis of reaching agreements. Should this mode of procedure fail, it is agreed that the whole matter should be submitted to conciliation and arbitration under the Industrial Disputes Act, or to such mutual arbitration as agreed upon by both parties to the disputes, and no strike or lock-out shall take place during the period of such action.

"Agreed to No. 7 and conclusion."

J. M. Pigott declared that in dealing with business agents the contractors are getting away from their men rather than closer to them. If the employers make a point to win an argument, it does not get down to the men and has no effect on the situation.

Tuesday Evening, January 17

Separate meetings of the general contractors section, the trade contractors' section and the supply dealers' section were held on Tuesday evening.

Wednesday Morning, January 18

John Grieve, chairman of the supply dealers' section, presided at the general session on Wednesday morning. Mr. Grieve read the list of exhibitors and requested the representatives of each firm to stand as their names were called.

Mr. Grieve then introduced Howard A. McGill, commodity statistician for the Babson Co., Wellesley Hills, Mass., who spoke on the outlook for 1922.

Mr. McGill said that among the favorable factors to be taken into consideration in any attempt to prophesy the future, are the strong financial conditions of the United States and Canada compared with other countries, and the fact that nationalization of advertising and standardization of merchandising are here to stay. Mr. Babson is a decided "bull" on Canada, said Mr. McGill, and believes that in the next 20 or 25 years it will have a more rapid growth than the United States or any other country, but that this is the "long swing" and will not materially affect the immediate situation.

To show present conditions, Mr. McGill stated that in the United States in 1913 the steel mills had 35,000,000 tons capacity, with 31,000,000 tons production. In 1920 the production was 40,000,000 tons. In 1921, the capacity was 55,000,000 tons annually, but the production was only 20,000,000 tons. Similarly the capacity of the cement mills in 1921 was 140,000,000 barrels annually, but they were producing only 100,000,000 barrels. It would be some time before the domestic and export demands would absorb the total productive capacity of all industries in either the United States or Canada.

The number of failures in 1921 was the largest in history, said Mr. McGill; scores of firms are being supported by the banks at present, and mergers and further failures will result in 1922, although the worst is over in this respect. The situation regarding failures can be appreciated, he said, when one realizes that during the war there were five times as many new incorporations each year as there were on the average during the ten years prior to the war.

All unemployment will not be absorbed during 1922, declared Mr. McGill. The correction of employment con-

ditions will be gradually effected by natural laws and tendencies. Wages are still inflated; the cost of living in the United States is still 67% above that of 1913, but it is expected that many of the necessities of life will be reduced in price this year; history shows that wages always trail behind the cost of living, but are inevitably adjusted.

Transportation, taxation and the tariff are matters that need readjustment, said Mr. McGill, and international relations must be improved before export trade can be resumed. In this connection it must be remembered, he said, that Europe owes the United States three or four billion dollars besides the eleven billion dollars of war debt.

There will be no radical recovery of industrial activity in 1922, thought Mr. McGill; the tendency is upward, but it will be gradual. The recovery since 1921 has been very moderate and probably a seasonal rather than a fundamental movement.

The situation is still very unbalanced, declared Mr. McGill, especially in regard to prices. Commodities are grouped into three classes at present. In one class the price is still abnormally high; in another class the price ranges from 10 to 25% above that of 1913 and is probably as low as can be reached; in the third class, the price has sunk lower than the 1913 level and is too low and will probably stiffen in the future.

As examples of the first class Mr. McGill quoted brick at 100% over 1913 prices (this quotation and all others in this and the next two paragraphs being in terms of United States prices), gingham 123%, lime 150%, petroleum 142%, silk 103%, and some chemicals (such as quinine, sulphate, etc.) 200% over 1913 prices.

As examples of the second class he quoted wool at 15% over 1913 prices, wheat 10%, quicksilver 21%, flour 19%, brass 8% and linseed oil 127% over 1913 prices.

As examples of the third class Mr. McGill quoted some non-ferrous metals such as copper, aluminum, lead and zinc at 20% under 1913 prices, corn 15%, oats 8%, rubber 82% and hogs 5% under 1913 prices.

The comparisons made in the above three paragraphs were based on wholesale prices, New York market, latest available quotations.

There cannot be a normal exchange of commodities under these conditions, asserted Mr. McGill, and it is most likely that the trend of commodity prices will be downward for the next 10 or 15 years, although in 1922 some will go up while others go down and the average may be about the same; in fact prices of some building materials may stiffen during the next two or three months, he said, but it will be merely a seasonal recovery. The stock market generally anticipates the commodity market by about six months, and it had forecast a recovery in prices in some lines.

The equipment industries, said Mr. McGill, are in a comparatively unfavorable position, and success in this line will depend on individual effort. In 1921 industries in this line worked only 40% of capacity; in 1922 it is expected that they will work to 60% capacity, or an increase of 50% in business, nevertheless there will be no radical period of prosperity.

Babson's sent out 700 letters to prominent contractors regarding construction costs, said Mr. McGill, and from the replies it was estimated that the cost of industrial construction today is 68% above the 1913 level, but the cost of residential construction is 100% over that of 1913. Building materials will no doubt reach a lower level, said Mr. McGill, but the process may be spread over a long period and two factors would tend to hold up prices for some time to come: (1) The need of residential construction all over the continent, and the fact that the worst of the industrial situation has been passed and the outlook is more encouraging; and (2) that there is not a burdensome supply of materials in sight for 1922.

There can be no radical building boom until material prices do get down to a lower level, declared Mr. McGill, and as they will not likely get down this year residential construction in 1922 may be limited, although better than 1921. The farmers will be very conservative in 1922, he said, and much of the building work will be in industrial

centres, hospitals, schools, public utility plants and public works.

Wednesday Afternoon, January 18

At the luncheon on Wednesday an address was delivered by Grove Smith, Dominion Fire Commissioner. When the general session was resumed at 2:30 p.m., W. H. Hall spoke on "Surety Bonds." He was followed by A. R. Whittemore, who reviewed the building activities in Canada during the past few years and agreed with the Babson statistician regarding trend of costs and the business outlook.

F. B. McFarren, chairman of the freight rates committee, read a paper on freight rates in the brick trade. The Board of Railway Commissioners, said Mr. McFarren, invariably follows the lead of United States authorities, and when the latter decided that brick is not an essential commodity and added 40% to the rates for its transportation, the Board at Ottawa had promptly followed suit. He reviewed the arguments that had been used in attempting to persuade the Commissioners to grant a reasonable rate, and declared that if the rate on brick were reduced the railways would not be burdened with so many idle cars.

Wednesday evening was devoted to committee meetings by some of the delegates, while others formed a party that attended the vaudeville show at the Lyric Theatre. Another large party of delegates witnessed a hockey match at the Hamilton Arena.

Thursday Morning, January 19

Practically the entire morning on Thursday was taken up by the presentation and discussion of a paper on "Construction Costs," by W. A. Connor, chief cost accountant of the Aberthaw Construction Co., Boston, Mass.

The system of cost keeping in vogue in the offices of the Aberthaw company was explained in detail. Slides showing the forms used in this system aided greatly in acquiring a thorough understanding of the methods discussed. In his opening remarks the speaker declared that a successful cost system is one that visualizes the work under construction. Many failures were due to the fact that the contractor had a faulty cost system and a poor knowledge of buying and selling.

Three functions entered into cost accounting that were absolutely essential, viz: Economical handling of work, ability to make a correct estimate, and sufficient data in regard to the nature of the work. Labor costs of any day's work should always be available not later than the next day.

The speaker expressed regret that in many concerns costs are kept secret from the foreman. Foremen should always be posted on the actual cost of operating their departments, and when costs are found to be lower in one department than another, the foreman responsible for the lower costs should be commended.

Of particular interest was the code system used by the Aberthaw company to aid the cost clerks and managers to visualize the structure during its erection.

In conclusion the speaker advised that considerable latitude be given to superintendents in the purchasing of material.

Discussing Mr. Connor's paper, Mr. Fuller, of the John V. Gray Construction Co., Toronto, advocated the use of the man-hour unit as well as the money unit in keeping costs. Mr. Fuller stated that his firm had devised a cost system that is simpler in some respects, and equally satisfactory, as that of the Aberthaw company. Cost work, said Mr. Fuller, should always be the basis of estimating. If the mill work costs \$10,000, some contractors say, "Double it to cover the labor." Then, if they have to lay a hundred thousand brick, they look at the plans and say offhand, "Fifteen dollars a thousand to lay that brick." Judgement and experience are essential in estimating, said Mr. Fuller, but they should be backed by cost data.

In his firm's cost system, said Mr. Fuller, overhead is entered on a separate sheet and not carried as a unit cost on each item. On that separate sheet is listed every im-

portant item of overhead cost that had appeared on any of their cost sheets during a 5-year period. Such items as plant charges, superintendence, clerical staff, workmen's compensation and government tax on material purchases are items that are separate from labor and material, and should not be entered as unit overhead costs.

Every firm, said Mr. Fuller, should have a proper quantity survey form that will indicate what is missed. Too frequently it is the fellow who has missed something who gets the job and then wonders why he failed. Mr. Fuller moved that the conference appoint a committee to devise a proper quantity survey system in order to determine what are the correct units for estimating. A standard system should be prepared and it should be adopted by all contractors, with a view toward having this work done in years to come by one organization on behalf of all contractors, and leading ultimately to the inauguration of the quantity survey system of calling for tenders. At present if ten contractors each spend \$100 in obtaining quantities for preparing a bid, that work has cost the industry the sum of \$1,000, whereas two separate surveys could be made and checked against each other for not more than \$300, and the quantities used by all ten contractors, thus saving \$700 to the industry as a whole.

Mr. Fuller declared that a committee of contractors who had looked into the subject recently had estimated that \$8,000,000 a year could be saved in Canada by the establishment of bureaux such as he suggested. Mr. Fuller's motion was referred to the executive in the form of a recommendation.

Thursday Afternoon, January 19

At the luncheon on Thursday the guests of honor were Senator Robertson, formerly Minister of Labor in the Dominion Government, and Hon. Walter Rollo, Minister of Labor in the Ontario Cabinet. Mr. Rollo was the speaker of the day. He called attention to the need for buildings of all kinds throughout Ontario, and advised the contractors to notify all prospective builders who had obtained quotations from them during the past few years but who had not proceeded with their plans, that costs are now lower and that this would be a good time to revive their plans. A large number of branch banks and other buildings had been contemplated last year in Ontario, said Mr. Rollo, but had been delayed because prices had been too high.

Mr. Rollo predicted the adoption of unemployment insurance. If manufacturers and farmers look to the government to supply them with an adequate amount of labor when they need it, how can the government take care of that labor when the labor is not needed on the farms or in industries? The only way he could see is by unemployment insurance, and if anyone has any better plan, the government should be advised of it, he said.

The cost, up to a few weeks ago, of the municipal relief work had been \$100,000 for the Ontario Government's share, said Mr. Rollo. The Dominion Government pays one-third, the provincial government a third and the municipality a third of the surplus or excess cost of any public works carried on during the winter as relief work to provide employment, the excess cost being the difference between the cost as relief work and the sum that the work would normally cost if carried out by contract in the construction season.

Mr. Rollo also made a plea for safer scaffolds and the enforcement of other provisions of the Building Trades Protection Act, and urged the contractors to "Bring Back Industry by Being Industrious."

After the conclusion of Mr. Rollo's speech, the remainder of the afternoon was devoted to trips of inspection. Fifty visiting delegates inspected the bascule bridge that is being built over the Burlington channel by the Hamilton Bridge Works Co. A special car was chartered on the radial line and the party were the guests of W. B. Champ, general manager of the Hamilton Bridge Works Co., who also entertained them at tea upon their return to the hotel. Sir John Hendrie, president of the company, welcomed the visitors at the bridge, and at the reception at the hotel Mr.

Champ was assisted by Major Ian Hendrie, assistant secretary of the company. Other parties visited the plants of the Ontario Gypsum Co., the National Fire Proofing Co., the Burlington Steel Co. and the Libbey-Owens Co.

Thursday Evening, January 19

The general business session was resumed at 8 p.m., Thursday, with President Anglin in the chair. The conference decided to devote the evening to a discussion of the labor situation. E. G. M. Cape, of Montreal, and J. M. Pigott, of Hamilton, presented an array of statistics and opinions bearing upon costs of labor and materials, and in order to throw light on certain subjects upon which there seemed to be varying opinions, the president called upon J. E. Sweeney, special representative of the Associated Building Employers of Michigan, who was a guest at the conference, to outline the experience of Michigan contractors.

Mr. Sweeney delivered an eloquent and forceful address that was a feature of the conference. He declared that production at the lowest possible price consistent with the welfare of the employee, the employer and the public is what must be sought to put the construction industry upon its feet. Production comes from competition. To be thorough and healthful, competition must have no unequitable restrictions imposed on it. Skill and zeal determine a man's value to an industry and all men skilled and willing must be permitted to compete freely and to lend the benefit of their skill and zeal to the rehabilitation of the industry. "We cannot afford to have either a union condition nor a non-union condition in the building industry," said Mr. Sweeney.

"The Associated Building Employers of Michigan have not been afraid to deal with what we consider the biggest problems first, and we consider the labor problem the biggest in the building business, even to the extent that we hold lack of production by labor responsible for the high freight rates. We have tackled this problem and have the most equitable and peaceful conditions to be found in labor circles in the country today.

"Our American Plan of Employment permits of union conditions prevailing if it is the wish of the employer so to deal with his workmen, but imposes restrictions to protect the public welfare. We have recognized that the question is a triangular affair, having in mind always the welfare of the public as well as the employer and the employee.

"Labor unions are primarily responsible for the unsavory public impression of the building industry in the United States today, and after them the next in the group largely to blame for the troubles of this industry are those groups of employers who have been willing to deal with absolute unionized groups of employees, or rather with their business agents.

"I believe the membership of the American Federation of Labor to be 150,000—that being the active number of business agents—rather than 4,000,000 as the others are all bystanders.

"In conferences, do not forget that there is only a border line between conference and conspiracy. Do not confer with labor so long and so closely that public suspicion be aroused and conspiracy be charged. Let us stand apart from labor. It is a check on our business to be quite apart from labor. The auditor does not sign our cheques and the book-keeper does not audit our books. The public must know what both sides are trying to do in all conferences with labor, and then they will have confidence in the industry."

Upon conclusion of Mr. Sweeney's remarks, the Labor Committee retired to discuss the various points that had been brought up, and Mr. Sweeney was invited to join the committee in an advisory capacity.

Under the direction of Grove Smith, Dominion Fire Commissioner, two reels of moving pictures were then shown to illustrate the advisability of automatic sprinkler protection for factories, schools and institutional buildings. In Canada, said Mr. Smith, the fire loss in 1921 was \$30,-430,000. In the last four years the loss has been \$123,-

000,000, and a sum of \$230,000,000 was paid to the insurance companies. Capitalize the unnecessary cost of the fire menace in Canada and we could readily pay off the national debt. In Great Britain, with a population of fifty million people, the loss in 1921 was only \$36,000,00, or very little more than the loss sustained by nine million Canadians. In Hamilton last year the loss was \$700,000. In Ipswich, England, a city of similar size, the loss was \$18,000.

The largest fire loss is not in districts where shacks predominate, said Mr. Smith, but in what might be called first class industrial buildings. Frequently the contents of a building are far from fireproof even though the building is practically fireproof, and in such cases automatic sprinklers are the only safe protection. They are 99% efficient and have had a splendid record in protecting property. About 500 lives are lost every year in fires in Canada, but not a life has been lost in a sprinklered building.

There were 160 fires last year in public or institutional buildings, yet only two institutional buildings in Canada are sprinklered. There are no less than 80 fires in schools every month, said Mr. Smith. All schools, jails, asylums, hospitals, institutional buildings and factories should be sprinklered. More attention should be paid to fire prevention in building construction, particularly in the case of jails, hospitals and institutions.

Friday Morning, January 20

At the general session on Friday morning Mr. Fuller again urged the appointment of a committee to study estimating and cost-keeping, to collect data on the subject and to prepare a standard system that can be generally adopted.

An amendment to the by-laws, permitting the election of four western members of the executive, was carried. It was decided that a vice-president should be elected each year from one of the four western provinces, and that he and the other four western members should form the Western Executive of the association and that they should meet three or four times each year, if possible, to discuss conditions in the west and to advise the association.

W. A. Wilson presented the aforementioned report on standard contract forms and standard practices.

President Anglin announced that at next year's conference a special projecting room would be supplied for the use of firms wishing to show industrial "movies." Various firms showed moving pictures whenever opportunity offered during the conference, but there was not time nor facilities to show all the films that were available, and it was decided that adequate facilities should be provided next year, as these movies are instructive and interesting, and if encouraged will doubtless form a growing feature of the annual conference. Among the interesting films shown this year were several reels by the Burlington Steel Co. and the Austin Mfg. Co. Other films available were several by Mussels Ltd. and the Steel Co. of Canada.

Mr. Dinsmore extended an invitation to the conference to meet next year in Windsor. Mr. Brousseau extended a similar invitation on behalf of Quebec. As the conference had already been held once in Manitoba and three times in Ontario, but never in Quebec Province, the delegates voted unanimously in favor of Quebec City.

A motion supporting the Ontario Provincial Exchange in their fight against the amendments to the Ontario lien law was referred to the Executive with full power to act.

Norman McLeod (Toronto) presented the aforementioned report of the special committee regarding social meetings and the use of a seal or insignia of the association, and the report was unanimously adopted.

The report of the nominating committee was received and adopted.

Mr. McFarren reported that the freight rates committee would not be able to present a final report until further data had been obtained and he recommended the appointment of a permanent committee. The president appointed Mr. McFarren, and Messrs. Nicholson (Toronto), Robertson (Toronto), McLeod (Toronto), Reid (Windsor), Eaton (Orillia), and Mattice (Montreal).

The following report was presented by J. M. Pigott, chairman of the Finance Committee:

"We have carefully considered the treasurer's report for the year ending Dec. 31, 1921, and have noted from this report that the year was started with a balance on hand of \$1,658.53, and that the year ended with a balance of \$21.60. It is evident, therefore, that if we did not have a large balance on hand at the beginning of the year, that this treasurer's report would have shown a deficit of \$1,600.

"The most important thing, therefore, in connection with this statement is that the receipts will have to be greatly increased if the work that the association is doing is to be carried on efficiently, and all the field that could and should be covered in order that an association of this kind can develop its true and proper value.

"The executive officers should certainly not be required to attend to the actual work through the year at their own expense and it is to be regretted that this should have been found necessary during the past year.

"The method employed in 1920 raising funds, on a commission basis, did not appeal to the members as a whole, perhaps, but, nevertheless, it is evident from a very casual examination that if it had not been for that campaign, it is doubtful if the association could have weathered the year 1922.

"This conference has done much to add to the importance and prestige of the association; it should prove easier now, year by year to spread the organization by increasing the membership.

"In the opinion of this committee, the present conference should be followed immediately by the engagement of a man of the highest qualifications — for a period of three or four months — for the purpose of covering the whole field by interesting the most reputable and responsible concerns in the various cities and towns of Canada, securing their membership applications, and leaving at that center some machinery in the hands of these reputable concerns for extending the list at their discretion.

"As to the conferences themselves, it is in our opinion a most important matter that every local association in Canada should be represented by at least two delegates. In order that the extreme east and west delegates may not be constantly at a disadvantage, in the matter of railway and pullman expenses, this committee strongly recommends that in preparation for the next annual conference, the secretary prepare figures of the cost of bringing two authorized delegates from every local in Canada, and that this expense be averaged up and all pay into the secretary the same amount.

"This might be of still greater benefit if where local associations came closer to the point selected for the conference, their delegations be increased to a point, for instance, where the large majority of the members of the local association should be included.

"In the short time at our disposal we have not been able to lay down any definite recommendation, but would leave the matter with the above suggestion to be worked out in detail later by the secretary, and, if feasible, adopted by the association through the executive before the next conference.

"Another suggestion, as an alternative, is that if the treasury can afford it, the expenses of at least one representative from each organization outside of the province where the conference is held, be paid."

Friday Afternoon, January 20

The guest of honor and speaker at the luncheon on Friday was Secretary Wormith of the Workmen's Compensation Board of Ontario, who reviewed the provisions of the Act in that province and outlined the Board's experiences. The cost of administration of the Act has been only 1½%. The assessment has averaged only \$1.22 per \$100 of payroll. The assessment has been much lower than in many states in the United States. For bricklayers, as an example, the rate in Ontario is \$1.80; in Ohio, \$2.90; in Wisconsin, \$3.78; and in New York, \$8.73.

Mr. Wormith explained the Board's system of rebates to contractors who are required to pay assessments in other

provinces, and the steps taken to prevent employees from recovering damages in more than one province.

In 1920 the Board paid \$7,000,000 in awards in connection with 54,000 accidents, and \$750,000 in medical and hospital and nursing expenses. In 7 years the Board has dealt with 271,000 accidents and has paid \$25,500,000 in awards. The payrolls upon which assessments were levied in 1920 totalled \$450,000,000.

Questioned by various delegates, Mr. Wormith stated that there is no credit rating in the construction industries at present to encourage a record of accident prevention by individual employers, but that there is such a credit system in all other classes of industry, and the spread between the best class and the worst class in any one industry averages about 45% in assessment rate.

James Mackie, vice-president of the association presided at the meeting immediately following the luncheon. J. B. Carswell, the newly elected president, was introduced and spoke briefly of the work before the association during the coming year.

Mr. Mackie presented a handsome cut-glass dish and a ring to E. B. Osborne, secretary of the Hamilton branch of the association, in recognition of the work that Mr. Osborne had done in organizing the convention.

The final report of the Labor Committee, as printed above, was received and unanimously adopted.

Resolutions of thanks were adopted, including one to the Department of Labor in respect to the May conference.

J. P. Anglin said that in organizing the association he had never hoped or intended that it should be developed to sufficient strength to be arbitrary or to impose its will upon the industry regardless of the rights of the public and the employees, but that he hoped that it would continue to exert a great moral influence that would be beneficial.

James Mackie, in adjourning the conference, stated that the association would never tackle its problems in the spirit of looking for trouble, and that at all times an equitable solution would be sought for difficulties, and that the public interest will be paramount.

NEW RECORD OUTPUT OF CANADIAN STEEL

PRODUCTION of steel ingots and castings in Canada during November, according to the Dominion Bureau of Statistics, showed a decided improvement, the output rising from a high record of 72,204 long tons in October to a total of 75,039 long tons. Of the November output, 73,806 tons were made by the producers for their own use, mostly in the manufacture of steel rails. A small amount was produced for direct sale, the total under this item being 1,233 long tons, practically all of which was in the form of steel castings.

The favorable turn in the steel making industry noted in October thus continued throughout November, although the principal activities reported were in the manufacture of steel ingots for further use in manufacturing processes. While, therefore, a considerable increase was noted in the output, the field of production remained somewhat limited. It has been nevertheless a matter of some satisfaction that there has been considerable improvement in at least one section of the steel trade.

The production of pig iron during November was fairly well maintained, the total output of basic iron amounting to 41,232 tons as compared with 42,356 tons in the preceding month. With the exception of some 300 tons, the whole output was produced by makers for their own further use. Foundry iron fell off slightly from 7,217 tons in October to 6,384 tons in November, practically all of which was produced for sale. No malleable iron has been made in Canada since August and no electric castings have been made since September. The quantity of the last-named commodity produced, however, is always small and is entirely the product of electric furnaces.

McKAY & McKAY, of Hamilton, Ont., have been again appointed engineers for the town of Burlington for the year 1922.

A MAINTENANCE DEPARTMENT, ITS FINANCING, ORGANIZATION AND OPERATION

Describes the Functions of a Highway Maintenance Division and Outlines Complete System of Organization and Operation. Says Cities are Judged by Condition of Roads and Streets

By W. A. Van Duzer

Assistant Maintenance Engineer, State Highway Department, Pennsylvania

IT IS incumbent upon any administration to construct durable highways and provide for their future maintenance, as the condition of such highways is at all times an indication of the progressiveness of such municipality or state. The future condition of the highway is treated by the people in an abstract sense, while their present condition is of vital and economic interest to them. The old method of hit and miss maintenance is obsolete. Present day practice requires that it must be carried on in a methodical manner and as a continuous operation.

Financing

The most important preliminary step in any private or public undertaking is its proper and logical financing. Funds should be made available each calendar year so as to permit the department to proceed with its studies and authorizations during the winter months.

I believe a highway engineer, knowing his traffic and having a history of the road's behavior in the past and the type of maintenance it received, can prescribe very intelligently at least five months in advance what the road will need the next season. This gives him and his organization plenty of time to perfect their plans, study the proper equipment and, if necessary, receive bids on the requisite materials, thus assuring, to a great extent, the completion of work before the advent of the season of heaviest travel.

The uncertainty as to the time that an appropriation will become available as well as the amount that will be appropriated are the principal reasons that have made it absolutely necessary to provide a fixed revenue to finance our ever-increasing maintenance. It is but natural that a Legislator, desirous of securing a large proportion of the maintenance funds for his county, should consider it his duty to his constituents to insist that these funds should be appropriated in county units, and a small fund provided which could be used at the discretion of the department in taking care of unforeseen contingencies. But traffic conditions, which are ever changing, have in the past few years become the real problem in proper maintenance, and are the disturbing element in specific county appropriations. The construction of a certain unimproved link, or the erection of mills, shops and other property along a highway can increase traffic to such an extent that appropriations made for a road a year or two in advance cannot meet its requirements, and therefore cause consequent deterioration and eventually make reconstruction necessary.

Availability of Funds Essential

To obtain the best results in any business, whether it be state or private, there must be a fairly definite time within which funds become available, in order that the work may be properly planned. Legislators, realizing this fact and being imbued with keen business sense, in many states have written into the statutes a provision that the fees derived from motor vehicle registrations may be applied towards the maintenance of highways on their state system.

In this manner the control and distribution of these funds are left to a great extent in the hands of the department and place it in a position to meet contingencies as they arise, thus assuring proper attention to the heavy travelled through roads. Experience has shown that this is the logical manner of handling this very important part of the problem.

Owing to the small mileage involved, the maintenance of roads not on the state highway system, but constructed with the assistance of the state, or special maintenance on

main trunk lines in boroughs or towns, can be taken care of by direct appropriation. These appropriations, however, should be made in a lump sum for the whole state.

Preparing a Maintenance Budget

The intelligent distribution of these funds must of necessity result in a budget, this budget being prepared from annual estimates furnished the main office by the representatives in the field. For convenience, we have divided these estimates into six general classes: Indirect expense is a charge covering salaries and expenses of the field offices and forces. General repairs, as the term implies, takes into account the different classifications for the proper maintenance of the total mileage of highways, the crowning and dragging of earth roads; placing of drainage other than bridges, and the necessary repairs to improved roads. Resurfacing, which includes the reconstruction of the different types of pavements already laid, either with the same material or with a higher type of construction. Surface treatment, which includes the purchase and application of the bituminous material and the chips or other covering material. Bridge construction, and repairs to tools and equipment, the last of which covers all necessary repairs to the tools and equipment of the maintenance division.

The preliminary estimates are prepared by the field representatives after a careful and thorough study of each route. The roads are gone over foot by foot, distributing each estimate among the several units of work coming under the various classifications. We will not allow any guess or approximation and hold the engineers strictly to actual figures, so that each engineer has a personal pride in seeing that the work is done within his estimate.

These estimates are totaled in the maintenance division under the different classifications and are gone over very carefully. In the event that the estimated amount required for these roads is in excess of the estimated revenues, it is necessary to make reductions. In the estimate for general repairs, the reduction is accomplished by comparing such estimate with the amount of money expended during the preceding three years upon the different roads, always endeavoring to develop work of a permanent character, such as widening, construction of guard rail, and the placing of surface and subsurface drainage at particular locations. The reduction in estimates for resurfacing is made after a personal inspection of each project by a maintenance inspector from the Maintenance Division, who takes into account the importance of the road, the traffic, and the possibility of substituting cheaper repairs. Reduction in surface treatment estimates is made by a personal inspection of the roads and a reference to the chart showing the character of the treatment they received in past years, together with an appraisal of the probable traffic that the road will carry during the coming season. Reduction in the bridge construction estimates is taken from the bridge records kept in the main office. These records are compiled from an actual inspection of each bridge, made by an engineer of the Bridge Division, which gives in detail the physical condition of each structure.

These estimates are then returned to the engineers with notations as to the advisability of the reduction or elimination of certain work and after the corrections have been made are again forwarded to the main office for approval and the issuance of the necessary authorizations.

Cooperation With Construction Division Necessary

In the preparation of the next season's work the closest co-operation exists between the Maintenance and Construction Divisions and whenever traffic requirements become such that our maintenance costs show the present type of construction cannot be held with economy, that particular section is recommended for a higher type of pavement. When our present system of highways was taken over by the state it included 396 miles of toll roads. The majority of these roads had been built of limestone macadam, and, due to a lack of revenue and increased traffic, had deteriorated to such an extent that when we assumed their maintenance it was a real problem to make such temporary repairs as

were necessary to carry them over until such time as funds became available for more permanent work.

In order to get the full benefit of each year's work, we early determined upon a regular maintenance program; that is, a definite program of resurfacing certain roads was planned for several years ahead with the thought of ultimately giving us improved through highways.

Control of Authorizations

Upon receipt of the final estimates, authorizations for the different classes of work are issued from the Maintenance Division. A code number system is used to readily designate the type of work and approximate location. These authorizations are issued in quintuple, one copy going to the several interested divisions or bureaus. This includes a copy to the Auditing Division, from which an account is opened up chargeable to this authorization; one to the Management Division as the co-ordinating division of the department; one to the Purchasing Bureau, in order that purchases can be checked against the authorizations; one to the Maintenance Division, for the purpose of record and control, and one to the district engineer, which is his notification of the specific amount he has been allotted for a particular project.

This authorization is the instrument used to control the funds and in no case can it be exceeded. It denotes the funds which are to be distributed over the entire season and, in the case of general repairs, the entire length of the route in the specified county.

Our field control of funds is vested in an Engineer's authorization, by which he apportions to the superintendent the funds for a certain definite amount of work which is listed on the face of the authorization, excepting in the cases of surface treatment and resurfacing, when the entire amount of the department authorization is issued. The engineer's authorization is issued in triplicate and forwarded to the Maintenance Division for approval. One copy is kept in that division for record and the other two returned to the district engineer, who retains one for his file and forwards the remaining copy to the superintendent as his notification that the work is authorized.

A special single entry ledger is used both in the field and main office to keep a record of expenditures. The purchase order, which is the authority for a vendor to furnish certain material to the Department, is considered as a liability. The main office receives a report each month upon each authorization issued, according to classifications. This, being summarized, gives us the total amount expended each month under each classification on every route in the entire state.

In order that there may be uniformity in all office procedure, a regular system of field office inspection and audit is employed. We can transfer any field representative from one office to another and the same system of book-keeping and filing will be in effect.

Cancellation or Transfer of Authorizations

Occasionally, the funds authorized for a certain project will be in excess of those actually required and by means of a cancellation and transfer report the engineer, with the approval of the maintenance engineer, may transfer funds from one project to any other authorization in his district coming under the same fund. Upon the completion of an authorization and at the end of the year a report is compiled by the superintendent, which itemizes all pay-rolls and purchases. This is in turn checked by the district engineer's office and is forwarded to the auditing division in the main office for check and record. Any unused amount, not specifically transferred to other work, automatically reverts to the general fund.

Tabulating of Costs

In the cost accounting the Hollerith tabulating system is used. Cost records are prepared from progress reports submitted by the field. These reports show the cost of each of the different items coming under the particular classification, and are filed under route number and

by different years. By referring to them we have a record under the jurisdiction of the Highway Department.

This gives you a brief outline of the functions necessary to the proper financing of maintenance work. The financing and organization are really so closely related that, in order to make certain details of the financing as clear as possible, it has been necessary to borrow some of the functions which would ordinarily come under organization, such as the checking and revision of estimates, issuing of authorizations and cancellation and transfer of funds.

Organization

An organization, to operate with as little friction as possible, must be so planned that divisions of authority do not overlap. Its principal success depends upon proper planning. This particularly applies to resurfacing and surface treatment work. The three outstanding features in planning a job are labor, equipment and material. Labor is taken care of by the local representative in the field. The equipment requirements of each engineer are submitted to the central office at the beginning of each season, showing the estimated time that the equipment will be in use upon each project in his district. This includes rollers, trucks, sprinklers, concrete mixers, asphalt plants and dump wagons, together with the available supply of equipment in his district. From this, a working chart is compiled showing the total amount of equipment in use in each district and the surplus which can be transferred to other districts in the state.

The purchase of materials is made by requisition drawn by the superintendent and approved by the district engineer and the central office. If competitive bids have not been previously received the superintendent asks for quotations from at least three producers and, providing the material meets the Department's specifications, a purchase order is drawn upon the vendor submitting the lowest quotation by the Purchasing Bureau.

The regular payment of approximately eight thousand men twice a month for seven or eight months in the year is a problem of some magnitude, for it means that if we are to keep efficient labor we must pay them promptly and correctly. We use a time card with the workman's name and number on it, the workman retaining the card. The number of hours worked is punched by the timekeeper or foreman each day. Our caretakers send a daily report card to the superintendent, showing the number of hours worked and the kind of work performed, these men working alone under the direct supervision of the superintendent. We believe the post card system is an incentive for the caretaker to produce good results.

The foreman keeps a time sheet and at the end of the pay period prepares a progress report showing the time worked by each workman upon the different units of work which is mailed to the superintendent with the time sheets. He checks the progress report and forwards it to the Auditing Division, the time sheets being retained in his office until the receipt of the checks. The checks are delivered personally to each workman by the superintendent, who receives the time card as a receipt for the delivered check. These time cards are then sorted according to route and pay period, and periodically forwarded to the Auditing Division where they are filed as a record of payment made. We think the most important feature of this method of payment is the personal contact with the superintendent. In this manner he becomes better acquainted with his employees and by checking up frequently in going over the road he can readily pick up any attempt to defraud the State.

From time to time pamphlets of instructions are issued to the maintenance employees, but we believe that the best results are obtained by frequent circular orders and the careful preparation of standards for carrying out the different methods of maintenance work.

As is noted above, considerable time is taken in the planning and scheduling of work previous to the actual operation. A schedule of the various types of maintenance showing the tentative dates of beginning and completing

work is submitted by the district engineer to the main office, and a careful followup is employed to assure the completion of all work authorized.

Handling Complaints

One of the most important functions of the Maintenance Division is the handling of complaints. These receive careful personal attention, no matter by whom written or the nature of the complaint involved, and we endeavor in each case to have a representative of the Department call upon the complainant and adjust the matter if it is within his power to do so. We take the position that the section of road in front of any man's house is to him the most important highway in the State and his opinion of the work performed by the department throughout the State is based to a great extent upon the manner in which his special case is handled. A record of these complaints is kept in the main office according to route and county, and, provided further complaints are received from other sources, an inspection and usually a call upon the complainants is made by a representative from the main office.

System of Reports

In order that our records may be complete and aid in centralized control, a series of reports, statements and charts have been developed covering each phase of the work, included among which is a weekly report made by the superintendents showing the roads covered by them during the past week and their condition. The surfacing and surface treatment reports are compiled in the field and forwarded to the main office. They show the amount of each particular type of work completed and from the information furnished a chart is compiled each week.

Snow Removal

Pennsylvania has organized its forces and equipment, for snow removal on approximately 1100 miles of improved main arteries. These roads are kept open for all kinds of traffic throughout the winter. This snow removal work is handled through the co-operation of the various local offices of the United States Weather Bureau. Postcard reports, showing the condition of each road at five o'clock in the evening, are mailed each day simultaneously to the Weather Bureau meteorologists and the main office, the weather bureaus furnishing this information to the newspapers. Prior to the receipt of this postcard we assume that the road is open unless advised by wire to the contrary.

Central Office Inspection

To standardize practices and methods, we have two maintenance inspectors who make periodic inspection of all State Highway Routes, submitting a report of their condition to the main office, together with their recommendations. They are usually accompanied on an inspection trip by the engineer of the district, or his representative, to whom is given instructions and advice on the handling of their maintenance work. These inspection reports show the progress of each job.

The field operations are directly in charge of the district engineer who has three or more counties, with usually three superintendents. Each district engineer has an office and is directly responsible for all construction and maintenance in his district. The superintendent, who also has an office and clerk, devotes his entire time to the details of maintenance work. He selects and makes requisition for the purchase of all materials and supplies, employs all labor and is directly responsible for the economical maintenance and operation of all equipment.

The success of the organization is dependent to a great extent upon the continuous and economical operation of equipment. We have worked out a complete equipment operation control chart. This is followed up closely by the main office and when any equipment is idle without any explanation it is immediately taken up with the superintendent in charge.

The field control of funds, as referred to in the early part of this paper, is entirely in the hands of the district engineer.

Each foreman, caretaker and truck driver must have an appointment card approved by the district engineer which shows his name, by whom he was recommended, amount he is to be paid and date the appointment is to become effective. This is forwarded in triplicate to the Maintenance Division for approval, one copy of which goes to the Pay-roll Bureau of the Auditing Division for its guidance in passing pay rolls and one copy each to the district engineer and superintendent showing that the appointment has been approved. In the case of truck drivers, the superintendent submits a questionnaire with the appointment card. The questionnaire gives details as to the ability of the applicant to operate motor equipment, and is approved by the equipment engineer before the man takes charge of department equipment.

Operation

The actual operation of the maintenance division is as closely interlocked with the organization as the organization is with the financing. It is very hard to differentiate in some cases between the two. We will assume that the organization has been determined upon and the actual operation is to take effect. The Maintenance Division selects the means to be employed in the repair or reconstruction of the roads, the development of standards and the preparation of instructions as to how to apply these standards and methods.

We have spoken several times regarding the necessity of planning and scheduling your work. Periodic inspection is also necessary and a real system of followup is very important if the best results are to be obtained. Of course, the principal problem for the field to solve is to have a thorough understanding of their roads, type and behavior under various conditions.

In the natural physical conditions to be overcome the study of drainage and local materials is most important. Our slogan from the first has been to repair a road with material in harmony with its original type, that is an earth road with earth, a gravel road with gravel, a stone road with stone.

In the resurfacing of the waterbound macadam type, we have always advocated the use of large stone, varying in size from $1\frac{1}{2}$ to $3\frac{1}{2}$ in.; this stone must be thoroughly locked by the roller before the application of the screenings; screenings to be from 0 to $\frac{5}{8}$ in. and well broomed in with push brooms in order to get a uniform coating; no water to be used until after the voids in the stone have been filled with screenings. The use of a tamping upon the grade and also upon the finished road is advocated. A straight edge should be used longitudinally. There should be just sufficient screenings to properly bind the road without leaving a cake on the top.

On newly built macadam roads, we believe the first surface treatment should be a low viscosity tar of about .5 of a gallon applied to each square yard. As much of the success of future applications depends upon the initial treatment, great care must be exercised to see that the road is thoroughly cleaned especially along the edges in order to insure a maximum penetration. The second application may be either a medium viscosity tar or asphalt, applying .25 to .3 of a gallon per square yard as the road requires, using from twenty to twenty-five pounds of quarter inch to inch chips to the square yard. A road thus treated should not require another treatment for at least a year, but we find that we obtain much better results if we treat our roads successively for the first three years, after which we may be able to omit the treatment for several seasons. We have obtained good results by placing a third treatment of hot asphalt, having an asphaltic content of 88 to 95 at 100 penetration, or a consistency (float test) of approximately 150 c.c. at 50 degrees centigrade. Usually from .15 to .25 of a gallon is applied per square yard, which requires from 30 to 40 pounds of covering material.

One very important function of the Maintenance Department is to make the roads as safe as possible for traffic. With this idea in view we have co-operated with the

railroads in the erection of advance warning signs at all grade crossings, which signs are placed 300 feet from crossing.

Standard danger and direction signs are used by the Department. These are constructed of cast iron and the base is placed in concrete. To augment the direction signs, we whitewash telephone poles to a height of six feet from the ground, which not alone directs the traveler to his destination but is of considerable advantage in traveling at night.

Maintenance work does not alone mean the proper patching and maintenance of the surface but also the proper care within the right-of-way lines. With this idea in view, we have insisted that superintendents place all their patching material in long piles outside of the ditch lines, and that all brush should be cut periodically, piled and burned. With this same idea in mind, where bituminous material is used in the patching of roads, we have constructed drum racks. It not only makes a much neater appearance, but saves the caretakers considerable time in drawing out the materials.

A checkerboard marking is used on abutments and wing walls of dangerous undergrade crossings, which shows up to great advantage as does also the center marking which has been adopted for divisional traffic lines on sharp curves.

The organization and operation of the Maintenance Division of any State can be arranged with a little modification, and the addition or subtraction of units, to conform with the above outline. The principle has been found correct. The changes on account of legal difficulties or geographical difference can be readily made. From the head of the Department to the humblest workman, there must be no break in the organization, no conflicting division of authority, no deliberation of Boards before action can be taken. It must work straight to the point, with but one object. Maintenance is as true an investment as construction. The smoothness requisite to good results is only arrived at after careful study of the problem. Paper read before the American Association of State Highway Officials, at Omaha, Neb.

MILEAGE OF GOOD ROADS BUILT IN QUEBEC IN 1921

Report of the Quebec Minister of Highways Shows that the Government Good Roads Policy Has Made Satisfactory Progress During Last Year

IN spite of the hard times the Province of Quebec has not been marking-time in regard to good road building but has rather been steadily forging ahead with that persistency which is characteristic of its population. This fact is fully demonstrated by the figures given out by the Hon. J. L. Perron, Quebec Minister of Highways, in his annual report which has just been tabled at the Legislative Assembly.

As a matter of fact, the results achieved during the last season can favorably stand comparison with those of the previous years, when the financial stringency was less acute and money more plentiful. For instance, a total of 416 miles of good roads have been built in this Province during 1921, compared with 452 miles in 1920, and 451 miles in 1919, as follows:

	1919	1920	1921
Waterbound macadam	93.94	82.70	55.437 mi.
Gravel	341.77	347.51	322.69 mi.
Bituminous macadam	6.87	13.24	12.773 mi.
Concrete	6.75	8.89	12.612 mi.
Asphaltic Concrete	3.07	none	none
Macadam with cold patch	none	none	5.759 mi.

451.40 452.34 416.271

It is also interesting to compare the mileage of roads under construction at the end of these three years, and also that of the roads that have been rebuilt during the same period.

	1919	1920	1921
Roads under construction	92.25	181.70	125.75
Roads rebuilt	5.8	14.16	30.41 mi.

The rebuilding of some of the oldest roads has been made necessary by the enormous increase of traffic and the ever-increasing capacity of motor trucks, especially in the vicinity of the city of Montreal. In most of the cases old waterbound macadam roads are resurfaced with bituminous macadam.

A distance of 120 miles has been added to the provincial highways of the Province of Quebec by the completion of the Beauce Junction-Sherbrooke highway, which establishes a direct connection between Sherbrooke and Quebec. The total mileage of the provincial highways, directly under the control of the Highways Department, is now of \$470.75 miles compared with 350 miles last year.

Considerable work has been done over the following main communication roads, which are likely to be declared provincial highways as soon as they are completed: Levis-St. Lambert, Montreal-Sherbrooke, Caughnawaga-Malone, Richmond-St. Francois due Lac, Laprarie-Lacolle, Levis-Sherbrooke, Beauceville-Sherbrooke, Levis-Rimouski, Hull-Aylmer, Montreal-Mont Laurier, and Montreal-Ottawa, (via Hull). Nearly 100 miles of roads have been built on these various routes and it is expected that at least two or three of them will be completed in the course of next season.

The Montreal-Sherbrooke road is the first on the list. Work has been carried on in no less than ten municipalities, along that road, during the last season and it is anticipated that it will be resumed with utmost activity from early spring. It is also understood that the Sorel-Montreal section of the Levis-St. Lambert road, on the south shore, will be completed by next fall. The same can be said of the first section of the Montreal-Mont Laurier road, which it is expected, will be completed as far as Ste. Agathe by the end of 1922.

The municipalities of the province continue to show a great interest in good roads, and they co-operate with the Government in a very efficient manner. The question of repairing and maintaining earth roads has been taken up with them with great success. The main difficulty at the beginning was to induce them to abolish the old system of individual work on the roads which was obsolete and unsatisfactory. To this end the government placed generous grants at the disposal of municipalities ready to take direct control of their roads and undertake what repairs and upkeep work that the government inspectors should deem to be necessary. The fact that no less than 646 municipalities, out of a total of 1,000, have taken advantage of this offer, fully demonstrate that the people of Quebec are well aware of the importance of good roads.

The Highways Department is looking for a banner year in 1922. With the appointment of a man of initiative and action like the Hon. J. L. Perron, as Minister of Highways, last September, it may be inferred that the good roads policy of the Government will receive all the care and attention it deserves.

Mr. Perron has made it clear to everybody that the good roads policy of the Government will not be discontinued. On the contrary, he is proposing to have the road law amended at the present session of the Legislature to authorize in certain special cases, especially in regard to the question of maintenance of provincial highways. He will also propose that the Government be authorized to borrow twenty millions more for good roads, as the thirty millions already authorized are nearly exhausted. He has also pledged himself to maintain in the best possible condition the 4,000 miles of improved roads. These roads have been built at great cost, during the last ten years, and Mr. Perron considers it a national duty that they should be maintained in first class order. It will be his first consideration, and all necessary repairs, on these 4,000 miles of roads, will be made early next spring. It has been estimated that no less than 42,000 tourist cars entered the Province of Quebec during last season, and it is expected that the 50,000 mark will be passed in 1922.

THE OPERATION OF SEWAGE TREATMENT PLANTS

Efficient Management Essential for Successful Operation of Sewage Treatment Plants. Weekly Report Suggested As a Means of Preventing Neglect and Consequent Breakdown of System

By John H. Dunlap,

Professor of Hydraulic and Sanitary Engineering, University of Iowa.

THE tendency of mankind to do the wrong thing, and to avoid thinking, is demonstrated forcibly in the operation of sewage treatment plants. In fact, the chief failures in operation are usually human failures. Doctor Thresh, Medical Officer of Health for the County of Essex, England, in an address before the Association of Managers of Sewage Disposal Works, once made a statement somewhat as follows:

"I have so repeatedly seen excellent works give bad results on account of inefficient management, and very defective works give fair results on account of the efficiency of the manager, that I have come to regard the manager as being even more important than the works."

In this connection the writer must confess that he has visited scores of sewage treatment plants, at one time or another, and has yet to find a plant which was not laboring under difficulties, usually of insufficient management. In making this statement, it would not be fair to place the blame upon the men who are theoretically in direct charge of operation of these plants. Usually the cause is farther back and may be located only by an analysis of our inefficient American plan of city and town government. The conduct of the business of our cities and towns is, by our American system, placed each biennium, for the most part, in the hands of new and untried men quite unacquainted with the city's business as a whole, and perhaps, failing to understand most disastrously of all, such a complicated machine as a sewage treatment plant. The common mistake made is to conclude that the sewage plant is automatic, and therefore needs little or no attention. Accordingly some individual like the water works superintendent, or the chief of police, or the city clerk, or some one who already has more to do than he can do, is assigned the task of operating the sewage treatment plant. Naturally, under these conditions the plant is neglected. The bacteria are to be depended upon to do their work if given a chance. The human factor, however, generally fails to function properly, with the costly result that the plant fails to perform its duty. Truly Dr. Thresh was right. The manager is of even greater importance than the works.

The Situation Throughout the United States

In order to ascertain how far the human factor involved in the operation of sewage treatment plants was performing its share of the work, a letter was sent to the sanitary engineers of the State Boards of Health of each of our 48 states. The letter requested an outline of the law, or of the rules, followed in the control of the operation of sewage treatment plants.

Forty-one replies to the 48 letters were received. Judging from these 41 replies, apparently only 18 states are now requiring the submission and approval of plans for sewage treatment plants by the State Board of Health. Only five states are requiring monthly reports, namely, West Virginia, Michigan, Kansas, New Jersey and Ohio. Only one is requiring licensed operators, namely, New Jersey.

The impression from reading these letters is that the general situation is very unsatisfactory. For instance, in the third annual report of the Department of Public Health of the State of Illinois for the period from July 1, 1919, to June 30, 1920, the following statement occurs:

"Experience has shown that there is a strong tendency among municipalities to neglect the operation of sewage treatment plants. It is a common, fallacious idea that sewage treatment works require little or no attention, and consequently they are neglected until objectionable conditions prevail because of odors from the plant or because of

stream pollution. Some sewage treatment plants have been so neglected that they have become permanently damaged and can be put back into operating condition only at considerable expense."

The situation in Connecticut is apparently much the same, as the following quotation from a letter from J. Frederick Jackson, Director of the Bureau of Engineering, indicates:

"I am sorry to say that very few of our plants, excepting the old sand filters, are properly operated. We endeavor to regulate them by occasional inspections and advice, but this is not satisfactory."

A Typical Example in Iowa

The writer was recently called in to advise a city council as to what was the matter with its sewage treatment plant. An inspection of the plant was made, which revealed the following facts. The Imhoff tanks were being operated like septic tanks, with a heavy scum on the sedimentation chambers and with the slots filled with sludge. The attendant in charge of the plant stated that he had been ordered by the city council to let this scum accumulate, since the council thought that this was the proper thing for the tanks, that they could not operate properly without the scum. Of course we all know that septic action in the sedimentation chambers of Imhoff tanks should be avoided, since it interferes with the process of sedimentation.

On taking soundings to determine the depths of sludge, it was found that the sludge was solid from the bottom of the beam forming the slots to the bottom of the tanks. Since no perforated pipes had been placed in the bottom of the tanks at the time of construction, it was impossible to apply water under pressure and agitate the sludge. Accordingly it could not be gotten out of the sludge pipes. Due to this fact, the sludge obtained from the tanks was not as well ripened as it ought to be and dried with difficulty on the sludge bed. Furthermore, a good deal of trouble was experienced with foaming from the gas vents. It was found later that the sludge capacity of the sludge digestion compartments was altogether too small for the population now connected to the sewers.

Two of the four sand filter beds were badly pooled notwithstanding the fact that 18 in. of sand had been added two months before to one of the filters, and at the same time 12 in. of sand to the other. The remaining two filters of the plant were flooded with sewage 6 to 8 in. in depth, and the sewage was flowing over one of the underdrain vents at the corner of one of the filters.

The trouble with the filters was that they were greatly overloaded, since their combined capacity was only about 2,200 people, whereas about 6,000 people were using the sewers. Furthermore, the past season has been an unusually wet one, and this particular sewer system admits large amounts of ground water and also some storm water runoff.

It will be observed that the trouble with this plant was again the human factor, in this instance principally the city council of six members, five of whom were new on the job this spring, who even went so far as to give the attendant instructions which were absolutely wrong in regard to the operation of the plant. Of course, the principal recommendations here were that the plant be increased in capacity to care for the present population connected to the sewers, and, furthermore, that a competent sanitary engineer be employed to have general charge of the operation of the plant.

A Suggested Way of Increasing Efficiency of Sewage Plant Operation

The way out from this inefficiency and this waste of investment in sewage treatment plants will consist in three steps, each of which though perhaps difficult to take, is necessary if a suitable return is to be made upon the large investments now required in sewage treatment plants.

In the first place it is believed that the State Board of Health should require the operator of every sewage treatment plant in the state to render a weekly report of daily operation. A form for such a weekly report is sug-

(To be printed on a postal card)
WEEKLY OPERATION REPORT OF THE SEWAGE TREATMENT PLANT

At		for the week ending		Submitted by		Filters		Outlet				
Sewage by-passed.		Tanks		Cameron or Imhoff.)		(Sand, sprinkling into or contact.)		(Name of creek, river, etc.)				
Day.	Hrs.	Counter.	Time.	Depth.	Sludge Re-moved.	Inf.	Settling solids.	Eff.	Condition.	Effluent stability.	Stability.	Hours spent at plant
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	
M.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
T.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
W.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
T.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
F.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
12. Remarks												

WHAT TO RECORD (To be placed on the left half of the front side of the postal card.)

Col. No.

1. Length of time in hours sewage was by-passed. Under remarks state reason.
2. Reading of counter in siphon chamber.
3. Exact time at which reading was taken.
4. Measure of depth of sludge in tanks at several points and record average depth.
5. Cubic feet of sludge run out, computed from dimensions of sludge bed.
6. Find c.c. of settling solids in 1 hour from influent. See directions for tests.
7. Find c.c. of settling solids in 1 hour from effluent. See directions for tests.
8. Condition as to surface mat, pooling, evenness of distribution of sewage, etc.
9. Number of days' retention of blue color. See directions for tests.
10. Collect sample about 100 ft. below outlet and record days' retention of blue color.
11. Record the number of hours spent in work at the plant.
12. Under remarks state any work not included in columns 1-11, such as removal of sludge from sludge bed, etc.

Suggested Form for Weekly Report on Operation of Sewage Treatment Plant

gested herewith. This form can be printed upon one side of an ordinary size postal card, and when filled out at the end of each week, mailed to the sanitary engineer of the State Board of Health. On the address side of the post card should be printed the address of the sanitary engineer of the State Board of Health, and then upon the left half of the front side can be printed certain directions as to what to record in each column.

It is believed that there are many advantages to be secured by requiring a weekly, rather than a monthly report from Iowa plants. For instance, the report card for a week is small enough so that it can be carried in the pocket of the operator, and filled out on the job when the readings and tests are made. Furthermore, the weekly report will aid in securing daily visits to the plant, and prompt knowledge by the sanitary engineer of the State Board of Health of neglect.

While the suggested form does not go much into detail, it does contain sufficient facts so that the sanitary engineer of the State Board of Health should know when plants are being operated properly. The facts called for are easily obtained. For instance, in column 1, the number of hours sewage is bypassed on any given day, and the reason for it, should be given in order that the state sanitary engineer may know just how much use is being made of the plant. The writer recently visited an expensive sewage treatment plant at which the sewage had been bypassed for a year's time, due to complete neglect on the part of the city authorities. A threatened law suit alone was able to get the plant put back again into operation, and then naturally, at considerable expense. The counter contemplated in columns 2 and 3, is one of the simple devices now on the market.

The depth of sludge in the tanks, columns 4 and 5, is an important matter, especially at this season of the year when it must be ascertained whether or not there is enough room in the sludge compartments for the winter's sludge. The tests for settling solids on the influent and effluent, columns 6 and 7, are simple to make. Imhoff conical settling glasses are used. One glass is filled with the sewage

as it enters the tank, and another with sewage as it leaves the tank. At the end of one or two hours the cubic centimeters of settling solids at the bottoms of the glasses may be read directly from the graduations on the glasses. The average removal of settling solids by Imhoff tanks as shown by these settling glasses, is about 95 per cent.

The condition of the filters, column 8, is of course an important part of the report, since on the average two-thirds of the organic matter in sewage is in solution, and therefore, must be oxidized by the action of the filters. The test for stability of the effluent, column 9, is very easily made. A sample of the effluent may be caught in a 4-ounce bottle, to which is added the proper proportion of methylene blue, by using an ordinary pipette. The number of days' retention of blue color, when the sample is kept at room temperature, is then noted. If the sample retains its blue color for four days, no nuisance will be caused by discharging it into an ordinary creek or ditch.

The test for stability of the mixed creek or river water and sewage effluent, column 10, is an important test in case the landowners below the plant should sue the city for damages due to supposed putrescibility of the creek water caused by the addition of sewage. The test is made in a manner similar to that upon the effluent from the filters. Of course full directions for these tests should be made in a small pamphlet to be issued by the State Board of Health.

Naturally column 11, hours spent at the plant, is one of the most important columns of the report. Under remarks, at the bottom of the card should be stated any work done, which is not included in columns 1-11, such as removal of sludge from the sludge bed, etc.

Operation Under Engineer When Necessary

The second step in the process of placing the operation of treatment plants upon a more scientific basis would be the appointment of a competent sanitary engineer in charge of a plant whenever the weekly operation report, or whenever a personal inspection on the part of the State Board of Health, shows that the plant is not being operated properly. It would not be necessary for the sanitary engi-

neer to devote much time to a given plant. By having copies of the weekly reports sent directly to him as well as to the sanitary engineer of the State Board of Health, and by giving the necessary instructions to the local attendant, proper operation of the plant could be obtained at all seasons of the year.

It is interesting to note that this recommendation was made in the Third Annual Report of the Department of Health of the State of Illinois already referred to. On page 64 of this report it is recommended:

"The burden of constant control of sewage treatment plants should not be borne by the state, but rather the municipalities should retain competent engineers to make sufficiently frequent examinations to insure proper operation. The state should, of course, supplement the work of these engineers and employees by periodical inspections of the plants at reasonable intervals, to check their operation and give advice which can often be based upon the experiences at other treatment plants."

General Directions for Operation of Plant Should Be Prepared

The third step in securing better operation of Iowa plants would include the preparation of a set of general directions for the operation of the various parts of sewage treatment plants of all types. This set of directions should contain drawings and photographs of the proper tools to be used in carrying out the directions. A description of the tests necessary, such as those for settling solids and stability, should be carefully explained. Furthermore, the State Board of Health might assist in obtaining the necessary equipment for making the tests by furnishing complete lists, stating where the equipment may be purchased, and its cost.

Conclusion

The fact that much of the investment in Iowa in sewage treatment plants is now a waste of money is to be regretted. Usually the fault is not with the design of the plants, or with the bacteria upon which the transformation of organic matter depends. The reason for this situation is due principally to the human factors involved in the operation of those plants. It is believed that the three steps of requiring weekly reports, operation under the charge of competent sanitary engineers where necessary, and the preparation of a carefully prepared set of directions will do much to remedy the present deplorable state of affairs. Of course all this presupposes that the Iowa State Board of Health will have funds to finance this extension of its work.

The final question, therefore, again involves the human equation: "Will the state pay the price?" We must not allow ourselves to forget that well-known axiom in the science of public health, propounded by the New York State Department of Health:

"Public health is purchasable. Within natural limitations any community can determine its own death rate."

Paper presented at Conference on the operation of Sewage Treatment Plants, held at Iowa State College, Oct. 27, 1921.

RAWPLUG CO. NOW ORGANIZED TO SUPPLY CANADIAN MARKET

RAWPLUGS, a device for enabling an ordinary screw to hold in any material, are now being put on the Canadian market after having met with very successful sale in England and the United States for the past two or three years. The plugs will be manufactured in Montreal by the Rawplug Co. of Canada; an affiliated company, Inventions Ltd., are acting as sole sales agents. H. Driver, formerly connected with the organization of the Rawplug factory in England, has been appointed managing director of Inventions Ltd., with offices at 128 Bleury St., Montreal.

Rawplugs are manufactured tubes of stiffened, longitudinal fibre strands, so cemented that once in position they can never crumble or pulp. Rawplugs are said to be unaffected by weather changes or moisture, and impervious to decay. The plug expands as the screw is inserted, be-

coming an integral part of the brick, concrete, plaster or other material in which it is placed. The screw automatically threads the Rawplug, thus permitting removal and reinserting as often as desired, without stripping threads.

The plug required to hold any screw is relatively very small, and only a small hole is required. The head of the screw entirely covers the hole. Mr. Driver states that millions of Rawplugs are now in use in Europe and the United States for fastening all kinds of devices to stone, slate, marble, glass, metals, plaster, brick, tile, concrete, hard rubber and other materials. They have proven especially valuable to contractors, engineers and others engaged in concrete and brick construction, and to electrical firms for use in all switchboard, conduit and wiring work.

Tests of Rawplugs under working conditions have shown a force as high as 1,250 lb. to be required as a direct pull to withdraw screws fixed with these plugs in stock brick, and 700 lb. for screws inserted in slate.

Discussing Rawplugs, "The Architect," of New York, says: "An excellent invention which will, we believe, meet with universal adoption in the building trades within a very short time."

BUILDING INDUSTRIES ASSOCIATION ELECTS OFFICERS

A RADICAL change in the system of financing its operation was adopted by the Hamilton branch of the Canadian Building and Construction Industries Association at its second annual meeting on Jan. 11. Instead of raising the operating expenses by means of a flat fee, the association was divided into three sections, each of which undertook to raise a fixed amount of the budget presented by the finance committee. The three sections are: The general contractors, the trade contractors and the manufacturers and supply men. Each section will raise the amount agreed upon by a system of assessment. This plan was adopted instead of the recommendation of the finance committee, that a membership drive be held and the initiation fee reduced for a short time.

The election of officers resulted as follows:

J. F. Mercer, president; J. M. Pigott, first vice-president; R. K. Palmer, second vice-president; Thos. Patterson, hon. secretary; Frank A. Magee, hon. treasurer.

Five committees were appointed and the chairmen of these are: Thos. Patterson, membership; Herbert Harper, finance; J. C. Stuart, labor; Guy Long, business relations; E. A. Wark, entertainment.

The trade contractors reported they were willing to handle all jobs initiated by the emergency employment committee of the citizens' relief committee at cost, plus a small percentage for overhead. This department reported that the matter of details of the team to help the unemployed situation would be worked out with George H. Lees, chairman of the citizens' committee.

No action was taken in regard to trade agreements or wages for the coming year, that matter being laid over till after the annual conference of the present association, which takes place in Hamilton next week.

It is reported that the Montreal Public Service Corporation, which is another subsidiary of the Montreal Tramways and Power Co., has applied to the Quebec Legislature for power to extend its operations through a large part of the province tributary to the site of the proposed Carillon development, and also to acquire and carry on the business of other companies using electricity within its territory limits. It is generally stated that a large sum of American money, probably eighteen to twenty million dollars, is being secured for this development, and that American interests have been here recently looking into the proposition. It is pointed out that even if the proposed development goes through, its effect upon tram power earnings is not likely to be felt very soon, as such construction as must be involved in the Carillon development would probably take two years to complete.

INTERNATIONAL JOINT COMMISSION RECOMMENDATIONS

ACCORDING to an announcement from Washington a detailed plan for the construction of the St. Lawrence ship channel and power development has been submitted to Congress together with the recommendations of the International Joint Commission which are as follows:

(1) That the Governments of the United States and Canada enter into an agreement by way of treaty for a scheme of improvement of the St. Lawrence River between Montreal and Lake Ontario.

(2) That the new Welland Ship Canal be embodied in the scheme and treated as a part thereof.

(3) That the proposed works between Montreal and Lake Ontario be based upon the report of the Engineering Board accompanying this report, but before any final decision is reached, the report of the board, together with such comments, criticisms and alternative plans as have been filed with the commission, be referred back to the board, enlarged by other leading members of the engineering profession.

(4) That there shall be an exhaustive investigation of the extent and character of the damage through flowage involved in the plan of development finally adopted.

(5) That, assuming the adoption of the plan of the Engineering Board, or of other plans also involving a readjustment of the international boundary, in order to bring each of the power houses on its own side of the boundary, appropriate steps be taken to transfer them to one country or the other, as the case may be, and the slight acreage of submerged land involved.

(6) That Canada proceed with the works necessary for the completion of the new Welland Ship Canal in accordance with the plans already decided upon by that country.

(7) That such "navigation works" as do not lie wholly within one country or are not capable of economical and efficient construction, maintenance and operation within one country, as complete and independent units, be maintained and operated by a board hereinafter called "The International Board," on which each country shall have equal representation.

(8) That "such navigation works" as lie wholly within one country and are capable of economical and efficient construction, maintenance and operation as complete and independent units, be maintained and operated by the country in which they are located, with the right of inspection by the said International Board, to insure economy and efficiency.

(9) That "power works" be built, installed and operated by and at the expense of the country in which they are located."

(10) That except as set forth in recommendation 11 the cost of all navigation works be apportioned between the two countries on the basis of the benefits each will receive from the new waterway, provided that during the period ending five years after completion of the works—and to be known as the construction period—the ratio fixing the amount chargeable to each country shall be determined upon by certain known factors such as the developed resources and foreign coastwise trade of each country within the territory economically tributary to the proposed waterway, and that that ratio shall be adjusted every five years thereafter and based upon the freight tonnage of each country actually using the waterway during the previous five-year period.

(11) That the cost of navigation works for the combined use of navigation and power over and above the cost of works necessary for navigation alone should be apportioned equally between the two countries.

Summary of Commission's Report

A summary of the report of the International Joint Commission has been issued which says in part "that the members of the commission as a result of their long and careful study of the situation from every possible angle, have reached the conclusion that the proposed deep waterway is practicable both from an engineering and an eco-

nomic standpoint, and that it would result in adding very materially to the prosperity of the two countries. So far as the United States is concerned, they believe that the benefit would be immediate. In the case of Canada, it might take a somewhat longer time to reap the full advantage of such a route.

"As to the engineering features of the improvement, the commission has had the benefit of the expert advice and assistance of a board of engineers created by the two Governments, Canada being represented by W. A. Bowden, chief engineer of the Department of Railways and Canals, and the United States by Col. W. P. Wooten, of the corps of engineers. This board, as a result of over a year's painstaking study and field work, filed with the commission a comprehensive report as to the best means of improving the river for both navigation and waterpower development in the international section of the river, that is, from Lake Ontario down to Cornwall, with the principal power works in the vicinity of the Long Sault Rapids, designed to produce about 1,500,000 horsepower, one-half of which would go to each country. In the purely Canadian section of the river from Cornwall down to Montreal, only a navigation system is provided, the development of power to be undertaken at some future date when the growing markets in Canada make it desirable. Locks and canals with a depth of 25 feet are provided for at the Long Sault, Valleyfield and Lachine. The estimated cost of the entire improvement, both for navigation and water power, is about \$252,000,000.

Problem of Cost

"Probably the most difficult and delicate problem the commission had to settle was how the cost of this international project could be divided between the two countries so as to put the thing on a fair and equitable basis. The commission's solution, as embodied in its report, is that the cost of that portion of the work chargeable to navigation should be divided on the basis of benefits received; that is to say, that each country should pay a proportion of the cost equivalent to the benefit it actually derives from the waterway. Obviously this principle involves the readjustment at periodical intervals, as the traffic develops on one side or the other. Provision is made for a tentative distribution during the construction period, based on the production and foreign trade of the territory economically tributary to the waterway on each side of the boundary. Further, in distributing the cost of the waterway, Canada is credited with her expenditures on the Welland ship canal, which is considered an essential part of the general scheme of improvement.

"These are in substance the recommendations of the International Joint Commission as embodied in its report to the Governments of Canada and the United States. It now rests with these Governments to accept or reject the recommendations as they see fit."

MAY BUILD BRIDGE AT LEASIDE

YORK Township is considering building a bridge from Leaside to Todmorden. County Engineer Frank Barber of Frank Barber & Associates, Toronto, at a meeting of ratepayers held at Todmorden, strongly advocated that the bridge be built. It would form the main part of a great north-eastern highway into the city. Its construction would break down the barriers which had prevented the development of a corner of Toronto's immediate suburbs 16 square miles in extent. The bridge, Mr. Barber declared, would connect Todmorden and the city south with Leaside and North Toronto. At present Todmorden is a stone's throw from Leaside as the crow flies, but 6 miles by road. Mr. Barber estimated the cost of the bridge at \$870,000, including the approaches, and the subway under C.P.R. and C.N.R. tracks. With approaches the bridge would be one mile and 20 feet long. The length of the bridge proper would be 1,400 feet, its height 130 feet, and its width 56 feet.

TORONTO SCHOOL BUILDING PROGRAM

ACCORDING to Business Administrator Pearce, the building program of the Board of Education for the year, which in preliminary estimates calls for the expenditure of \$2,711,700, will include \$695,000 for High Schools—\$450,000 being for the new Jarvis Collegiate, \$150,000 for adding eight rooms to Humberdale, \$95,000 for adding six rooms to Harbord, and \$30,000 for additional property for North Toronto High Schools. The total of nearly three million dollars required also includes \$1,338,000 to provide 92 grade class rooms, and \$522,000 for new sites. Schools already under construction call for \$66,700, and the High School of Commerce will have to be completed at a cost of \$60,000.

The additions to the various schools and additional sites will cost as follows:

To relieve congestion at Balmy Beach, Williamson Road and Kimberley Schools, eight new rooms are required at a cost of \$118,000, site \$30,000; total, 148,000.

Norway and Roden, 8 rooms, \$180,000.

Gledhill 4-room addition, \$65,000.

Morse and Leslie, 8 rooms, \$118,000; site, \$40,000; total, \$158,000.

North Rosedale, 8-room new building, \$118,000.

Bedford Park, site, \$40,000.

McMurrich, 6-room addition, \$95,000.

Carlton and Hughes, 8 rooms, \$118,000; new site, \$25,000; total, \$143,000.

Ryerson, Manning, Niagara, Brant and King Edward, 12 rooms, \$160,000; site, \$90,000; total, \$250,000.

Ogden, McCaul, Landsdowne and Orde, 12 rooms, \$160,000; site, \$50,000; total, \$210,000.

Hester How, 3-room addition, \$45,000; site, \$30,000; total, \$75,000.

Grace, Givens, Alexander Muir, 8 rooms, \$118,000, site, \$90,000; total, \$208,000.

Parkdale, 3-room addition, \$45,000; site, \$7,000; total, \$52,000.

Runnymede, 4-room addition, \$60,000.

New site between Wilkinson and Gledhill, \$40,000.

ASSOCIATED MANUFACTURERS OF WATER PURIFYING EQUIPMENT

AT a meeting of the executive committee of the Associated Manufacturers of Water Purifying Equipment held in Pittsburgh, Pa., at the Wm. Penn Hotel on January 7, 1922, it was decided to hold the annual meeting at the Bellevue-Stratford Hotel, Philadelphia, Pa., on February 7. A full attendance is expected as several matters of importance will be taken up for final determination, one of the most important being the adoption of standard specification requirements for pressure filters for various services, to the end that architects and engineers may have a standard to which all bidders must comply.

In the past there have often been as many different sizes of filters for the same service as there were bidders, which caused confusion to the purchaser as to which might be most suitable to his requirements. This often resulted in the purchase of apparatus entirely inadequate and unsatisfactory, and detrimental to business. This Association has in its membership practically all the builders of water purification apparatus. M. F. Newman, of the W. B. Scaife & Sons Co., is president. G. F. Hodkinson, of the American Water Softener Co., vice-president, and H. G. Tate of the Berronite Company of America, secretary.

CONSTRUCTION OUTLOOK DISCUSSED AT TORONTO BRANCH, E.I.C.

PRONOUNCED activity in the construction industry in the very near future was prophesied by H. W. Pepper, of the MacLean Building Reports, Ltd., in speaking before the Toronto Branch of the Engineering Institute of Canada, on Jan. 19. According to the speaker, the construction industry is the greatest one in this country with the

exception of agriculture. It is altogether the greatest in terms of labor employment. There is a volume of deferred construction, said Mr. Pepper, amounting to one and a quarter billions of dollars. Apparently labor is responsible for a great deal of this slowing up, since the cost of building labor is off from the peak of 1920 only about 10%, while materials are off 50%.

J. M. Oxley, continuing the discussion exhibited a chart showing the variation of wages for common labor, of the "Engineering News-Record" construction cost index and of the cost of living from 1913 to 1921. Labor is now getting in terms of the cost of living, said Mr. Oxley, 50% more than it did in 1913.

Notice of motion that the Branch by-laws be amended to conform to the length of session now adopted and so as to remove certain ambiguities was given by J. M. Oxley. While the formal discussion will be held on Jan. 26, an informal one took place on the notice of motion.

On account of the illness of the chairman, William Storie, vice-chairman, presided.

OTTAWA ENGINEERS ELECT OFFICERS

AT the annual meeting of the Ottawa branch of the Engineering Institute of Canada, held in the Daffodil Tea Rooms on Jan. 12, which was largely attended by local engineers, the following officers were elected for the ensuing year.

Chairman, K. M. Cameron, assistant engineer, Department of Public Works; secretary treasurer, F. C. C. Lynch, superintendent of natural resources, Interior Department; executive committee, O. S. Finnie, administrator of the Northern Territories, Interior Department; A. Ferguson, inspecting engineer, Department of Railways and Canals; A. B. Lamb, Dominion Water Power Department; C. M. Pitts, Pitts Construction Co.; J. L. Rannie, Geodetic survey.

The meeting terminated one of the most successful years in the history of the branch, largely due, it was stated, to the energetic leadership and untiring efforts of the genial retiring chairman, Commander C. P. Edwards, D.S.O. The financial statement showed a substantial credit for the year. It was also stated that 41 new members had been accepted into the branch.

The vote of thanks to the retiring chairman was moved by George Mountain, chief engineer to the railway commission, who eulogized Commander Edwards after a witty fashion, and concluded by making him a "presentation" on behalf of the branch.

The activities of the branch for the coming year were outlined by the new chairman, when returning thanks for his election, and he announced that the "Engineers' Ball" under the distinguished patronage of Their Excellencies the Governor General and Lady Byng of Vimy, would be held at the Chateau Laurier on January 26. Amongst the subjects of lectures and addresses to be given during the ensuing year are "Good Roads," by George Hogarth, chief engineer, provincial department of highways, Toronto; "Standards," by R. J. Durley, secretary, Canadian Engineering Standards Association; "Canadian Forestry Corps in France," by Major R. H. Nelles; and "Concrete," by Col. H. C. Boyden, of Chicago.

In the December 8, 1921, issue of "The Canadian Engineer" an article appeared by Mr. H. L. Seymour, entitled, "A Compilation of Town Planning Legislation, Province of Ontario." Unfortunately this article omitted to state that the author, Mr. Seymour, was indebted for the information it contained to the following gentlemen: Mr. Thos. Adams, Federal Town Planning Adviser, Messrs. J. B. O'Brien and A. E. K. Bunnell of the Civic Guild, Toronto, and Mr. T. D. LeMay, City Surveyor, Toronto.

Over five hundred engineers will assemble in Montreal this week for the annual general meeting of the Engineering Institute of Canada. An interesting program has been arranged and a number of important addresses will be given.

Letters to the Editor

Sir: I beg to draw your attention to a report contained on page 116 of your issue of the 3rd instant, concerning certain activities of the London Branch of the Engineering Institute of Canada, which is most erroneous.

In the first place the matter of petitioning the Ontario Legislature to make the engineering profession a closed one and together with other branch Institutes to present a petition to the Government at an early date praying that legislation to that end be spread on the Ontario Statutes, has never been considered or discussed. The proposed engineering legislation, while protecting qualified engineers, is primarily intended to protect the public interests. The whole intent of the Bill is to place the engineering profession on a similar footing to the profession of law and medicine and it might be pointed out that similar legislation, to that proposed for the Province of Ontario, has already become law in all Provinces of the Dominion excepting in Alberta and Prince Edward Island.

Then in the second paragraph of the report referred to a most absurd statement is made to the effect that, a closed engineering profession means that no one would be allowed to do engineering work unless he was a member of the Engineering Institute of Canada and membership in that body is made contingent upon the applicant for admission holding a degree from a qualified school of science. A mere glance at the proposed Engineering Bill would show that this statement is absurd for the reason that the Engineering Institute of Canada is only one of the several constituent bodies of engineers, surveyors, etc., that would be represented in the proposed body of Professional Engineers; furthermore, membership even in the Engineering Institute of Canada is not contingent upon the applicant holding a degree from a qualified school of science.

As representing the London Branch of the Engineering Institute of Canada I would ask that you publish in your next issue this correction of the report referred to.

Yours truly,

GEO. C. WRIGHT,

Secretary, London Branch Eng. Inst. of Canada.

Sir: In an item headed "Want Engineering Profession Protected" on page 116 of "The Canadian Engineer" of January 3rd, information is furnished your general readers in which the following paragraph appears:

"A closed engineering profession means that no one would be allowed to do engineering work unless he was a member of the Engineering Institute of Canada, and membership in that body is made contingent upon the applicant for admission holding a degree from a qualified school of science."

The information in this paragraph is not only inaccurate and misleading, but may, unless promptly corrected, work an injustice to the engineering profession in Ontario.

As one of the two representatives of the Ontario Provincial Division on the original Advisory Conference Committee, and as one who had to do with the organization of this committee, I am in a position to state most emphatically that there has never, at any stage of the movement for appropriate legislation to define the status of the engineer in Ontario, been any action taken or even attempted, on the part of those in official authority anywhere in the Engineering Institute of Canada to dominate in any manner, shape, or form, any efforts on behalf of the engineering profession in Ontario for legislation. On the contrary, however, the Engineering Institute did, notwithstanding its predominant numerical strength in Ontario, take the initiative in suggesting to other professional engineering bodies, the formation of the Advisory Conference Committee, upon which the Institute had but two members, the same as the

membership for other bodies — one for instance which had but five per cent of the numerical strength of the Institute.

This action was taken by the Provincial Division upon the advice of Council of the Engineering Institute in order that there should be no doubt whatever about the desire of the Institute to work in the closest possible harmony with other professional engineering bodies for the general good of the profession, wherever and whenever such action was possible. It was particularly realized that in so far as the province of Ontario was concerned, all action of the Institute should be taken with full appreciation for the powers and prerogatives of other organizations interested in the advance of the engineering profession.

At no time in the course of the work of this Advisory Conference, in none of their reports, and in no action which the Committee has taken, has there ever been any thought that membership in the Engineering Institute of Canada, or indeed in any professional body except the Ontario Land Surveyors, could prove a prime factor in the question of qualification for membership in any association of engineers which might be set up pursuant to the desired legislation.

As one of the original members of the Advisory Conference Committee perhaps I may be permitted to express a wish that this letter be published, in order that the impression given in your paragraph referred to above in the news item of your last issue be corrected.

Yours very truly,

J. B. CHALLIES.

Ottawa, Jan. 13, 1922.

GREATER WINNIPEG WATER DISTRICT

To Take in Town of Tuxedo — Transcona Authorities Sell Water to C.N.R. Shops

PART of the town of Tuxedo, Man., entered the Greater Winnipeg Water District last summer. Legislation will be introduced at the next session of the Manitoba Legislature to bring the whole town properly within the District, but there will be no engineering or construction work involved in this procedure.

The town of Transcona, Man., which is the municipality which first draws water from the Shoal Lake aqueduct, and which has its own pumping station and reservoir, recently entered into agreement with the Canadian National Railway to have the railways shops at Transcona take its entire water supply from the town. The consumption of the shops will be approximately three hundred gallons per annum. This quantity will undoubtedly be increased at a later date.

Only three of the municipalities at present comprising the Greater Winnipeg Water District are supplied directly from the Shoal Lake aqueduct, these being the city of Winnipeg, whose reservoir is the terminal of the aqueduct; the city of Boniface, whose reservoir is immediately adjacent to the aqueduct; and the town of Transcona, which has a separate connection direct from the aqueduct, built by the District at its own expense.

The municipalities of Fort Garry, Assiniboia, East Kildonan and West Kildonan are supplied from the distribution mains of the city of Winnipeg, and the municipality of St. Vital is supplied from the distribution mains of the city of St. Boniface. This arrangement is merely an extension or continuance of an arrangement which existed between these municipalities before the Greater Winnipeg Water District came into existence.

None of these smaller municipalities operate their own pumping station. They purchase the water from the District and the pressure from either the city of Winnipeg or the city of St. Boniface, both the cities and the District being paid at a fixed rate per thousand gallons of consumption. This arrangement will be continued until such time as the consumption of the smaller municipalities increases sufficiently to warrant the construction of a direct connection to the aqueduct.

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LEGISLATION NEEDED IN ONTARIO

MEMBERS of at least seven engineering societies in the Province of Ontario are co-operating in the preparation of a Bill for regulating the practice of engineering, to be introduced in the Ontario Legislature this winter. A similar Bill was introduced last winter, and, as our readers will remember, was heartily supported by "The Canadian Engineer" in a number of editorials which strongly urged the adoption of the Bill and which pointed out the fairness of, and the necessity for, the proposed legislation. "The Canadian Engineer" has had no reason to change its attitude toward this legislation, and believes that the Ontario legislators should adopt it at the earliest possible date; and in fact, that some such measure for the regulation of the profession should have been put upon the statute books of the province years ago.

In our issue of January 3 there appeared a news item from a London, Ont., correspondent, intimating that should the profession be "closed," nobody would be allowed to practice engineering unless he were a member of the Engineering Institute of Canada, and that membership in that body is contingent upon the holding of a degree from a qualified school of science. We regret the publication of this item, which was inserted during the absence of the editor, through illness, because everyone who is familiar with the efforts of engineers in Ontario to secure fair legislation knows that the Engineering Institute is only one of a number of engineering societies that desire such legislation, and that there is no suggestion in the proposed Bill of any requirement for membership in the Institute in order to practice engineering in Ontario. Moreover, all who are familiar with the Engineering Institute of Canada know that there are many members of that Institute who have never attended any school of science, and that any qualified

engineer can be elected to membership in the Institute, regardless of any lack of university degrees.

In almost every paper, news items can be found occasionally which are contrary to the editorial policy of the paper. Also, unfortunately, it is at times difficult to prevent the appearance of a news item that is totally wrong and unfounded. Readers of "The Canadian Engineer" may be assured, however, that it is the aim of this paper to have its news columns as correct as possible, and as much in line with the editorial policy as possible, and where errors are made, we have no hesitation in confessing the mistake and publishing a correction. Two letters, calling our attention to the above-mentioned error, appear in another column of this issue. We heartily concur with the statements of the writers of those letters, and thank them for having called our attention to this unfortunate item, which should not have been allowed to get into type.

FUTURE SOURCES OF ENERGY

SERIOUS stocktaking of the world's supply of energy took place at a meeting of the American Chemical Society last autumn. Scientists and engineers of vision are keenly aware of the fact that the source of energy contained in fossil coal, allowing for the rapidly growing consumption, will not be available for more than about 1500 years. At the same time, the reserves of petroleum are rapidly being depleted. The United States, which consumes 80% of the world's output, has remaining only an ascertained supply of 7,000,000,000 bbl. from which it is drawing at the rate of nearly 400,000,000 bbl. a year on a rapidly rising curve of production. In view of the constant increase in the number of motor vehicles, it is estimated that the gasoline demand for the United States will be 300,000,000 bbl. in 1930. It therefore appears that however useful and valuable the oil supplies of this continent may be, they are at best a short-lived asset. Natural gas is, too, a waning asset. When it is considered that about as much gas is wasted as used, the known supply cannot be counted upon for any great period.

With the prospect of lessening supplies of power for fuel, attention is bound to be focused more and more upon hydro-electric energy. It is fortunate that this country is singularly well supplied with this source of power. Estimates place the total water power possibilities of Canada at nearly 20,000,000 h.p., of which about 12,000,000 are available in the provinces of Ontario and Quebec. The available horse power per capita is over twice as great as in the United States, and is larger than for any other country, except sparsely settled countries such as Iceland and Norway. Of the total available power in Canada, only about one-eighth has actually been developed, so that we have a resource that should enable us to view with less alarm than might otherwise be the case the possibility of dwindling fuel supplies.

Renewed attention has been directed during recent years to the utilization of the power of tides. The most promising project of this character that has been outlined is the proposed tidal power development in the estuary of the Severn River in England. Taking advantage of the 30-ft. tide, it is proposed to build a dam across this body of water, so arranged as to trap the rising tide and lead it through turbines when the tide is falling. A total steady output of about half a million horse power will thus be provided, although an installation of over 1,000,000 h.p. will be necessary to provide the estimated block of power on a continuous basis. In order that energy may be available during the period of rising tide, the excess of power obtained when the turbines are operating is used to pump water into a reservoir in the valley of the river Wye, from which energy is obtained when the plant would otherwise be shut down. This development is calculated to save about three or four million tons of coal per annum and to offer such collateral advantages by way of providing a road and railway viaduct across the estuary and accommodation for shipping in the basin above, that the project is regarded as a promising one financially.

It is natural that in this general inquiry as to possible sources of energy, attention should once again turn to the energy derivable from the wind and the heat of the sun. While small quantities of power may be obtained from the wind, it is too variable and uncertain a source to be considered for any more than purely trifling requirements. Science is turning, however, with more and more interest to the possibility of utilizing solar energy. It will be remembered that John Ericsson nearly forty years ago obtained 1 h.p. with a mirror having an opening of ten square meters. Shuman undertook the construction of a solar engine near Cairo, in Egypt, but was not able to obtain the amount of power derived by Ericsson. However, it is seriously believed that a renewed study of the problem would show it to be feasible to derive useful blocks of energy from solar installations on the great deserts, or wherever long periods of continuous sunshine may be counted upon.

Apart from these definitely known sources of energy, engineers of a speculative turn are disposed to look forward to the ultimate utilization of atomic energy. While such is probably a long distance in the future, it is interesting to reflect on the observation of Sir Ernest Rutherford that "The human race may date its development from the discovery of a method of utilizing atomic energy."

PERSONALS

WILLIAM WALKER has been elected chairman of the Water Commission of Windsor, Ont.

JOHN A. CAMPBELL has been appointed Water Works Engineer for the town of Dresden, Ont.

ARTHUR ST. LAURENT has succeeded the late Eugene D. Lafleur as chief engineer of the Department of Public Works, Ottawa.

WILLIAM KEITH, Reeve of Newmarket, has been re-elected Chairman of the Toronto and York Roads Commission.

A.L.D. C. E. TISDALL, at one time Minister of Public Works in the British Columbia Provincial Legislature, has been elected mayor of Vancouver.

L. G. READ has just been appointed Consulting Engineer for the National Water Main Cleaning Company of New York with head quarters at Bridgeport, Conn.

W. K. SANDERSON has been again elected chairman of the St. Thomas, Ont., Hydro-Electric Power Commission. Mr. Sanderson was first elected chairman in 1914 when hydro was introduced into the city of St. Thomas and has been re-elected every year since.

E. A. LUNDERVILLE, formerly purchasing agent and comptroller of the Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que., has been appointed as sales manager of the Bawden Machine Co., Ltd., Toronto. Mr. Lunderville resigned from the Rand Co. in 1917 in order to enter business on his own account. He purchased the plant of the Colonial Machinery Co. at Cowansville, Que., and became president and manager of that firm, but recently sold his plant to local interests and moved to Toronto.

T. KENNARD THOMSON, consulting engineer of New York City, delivered an address before the Peterborough branch of the Engineering Institute of Canada entitled "Some Problems of a Consulting Engineer." In the course of his address Dr. Thomson made reference to the power possibilities of the Niagara and St. Lawrence Rivers and also dealt with caisson work and other interesting engineering problems. Dr. Thomson graduated from University of Toronto in 1886, secured his degree of C.E. in 1892 and his D.Sc. in 1913.

HON. WILLIAM C. KENNEDY, the new Minister of Railways and Canals in the Dominion Government has been in the House of Commons since 1917. He has always been regarded as a forceful speaker and a clever politician. He was one of those chosen by the Prime Minister to accompany him on his recent campaign tour, and following the election. Mr. Kennedy was born on August 27, 1868, in

the city of Ottawa, a son of William Kennedy and his wife, Julia Costello, both Irish. He was educated in Toronto. He now resides in Windsor, Ont., and is a gas and oil operator.

OBITUARIES

MILTON C. JACKSON, for many years a contractor in Nanawee, Ont., and later in Toronto, died in Toronto on January 13, aged 74.

JOHN EDGAR SHOWLER, at one time a prominent builder and contractor of London, Ont., died in Winnipeg on January 13, aged 75.

EUGENE D. LAFLEUR, chief engineer of the Department of Public Works, Ottawa, died on the 14th instant in his sixty-second year. Mr. Lafleur was a graduate of Ecole Polytechnique, Montreal, and also a member of the Engineering Institute of Canada. He was in charge of the surveys of the Georgian Bay Canal in 1904-5, and was appointed to his present position in 1904. He was one of the promoters of the Manitou Oil & Gas Company and reported on the proposed Prince Edward Island tunnel in 1906.

ARTHUR E. B. HILL, B.A. Sc., M.E.I.C., died in Vancouver on Jan. 12, aged 76. The deceased was born at Hillside, N. S., and graduated from McGill University in 1875. He joined the engineering staff of the C.P.R. in 1881, but went west in 1886 to take up the position as engineer and manager of the Coquitlam Waterworks Co. Later he designed and supervised the construction of the waterworks system of New Westminster. He was employed on the final location and construction of the C.P.R. in British Columbia during the early years, when the railroad was being built through the Rockies.

ROBERT W. THOMSON, mining engineer, died at Kamloops, B.C., on the seventh inst. Mr. Thomson graduated from the University of Toronto in 1893 and went directly to South Africa and entered mining work in Johannesburg, later occupying responsible posts in the mining operations of the Rand. He saw service in connection with the restoration of order at the time of the Jameson raid and was obliged to leave the country during the Boer war. After the war he returned and took up the work at the mines where he remained until 1908 when failing health compelled him to return to Canada. In 1910 he resumed practice in Canada and at the time of his demise he was District Mining Engineer for British Columbia.

PUBLICATIONS RECEIVED

DEEP WELL PUMPS—Catalogue B issued by the Chippawa Pump Co., Inc., Chippawa Falls, Wis.; 32 pages and cover, 6% by 9% in., printed in two colors on coated paper; well illustrated.

THE MINISTRY OF HEALTH REQUIREMENTS AS TO SEWAGE PURIFICATION by S. H. Adams, A.M.E.I.C. To those who have to do with the design, construction and operation of sewage disposal works this book, written by one who has had so extensive and unique an experience in this phase of sanitary engineering work will prove of great interest.

The book contains thirty-nine pages and covers the history of sewage disposal, makes important quotations from the reports of the Royal Commission, in addition to many interesting tables and diagrams all of which are calculated to be of specific and practical use to those who are concerned with sewage disposal work. There are tables covering rainfall, pumps, electrical pumping and many others, all of which will be found of great reference value to sanitary engineers generally.

The author who has devoted a life time to the study of such questions as this has in the preparation and publication of this book, made a distinct contribution to the literature of the subject.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

Construction news items, including notes of various tenders called, are published on pages 41 to 50 of this issue. The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported on the above-mentioned pages. The word "Issue" refers to the issue of "The Canadian Engineer" in which there appeared a notice giving some details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Ottawa, Ont., supply of steel pipe, valves and fittings	Jan. 31	Jan. 3
Orillia, Ont., supply of road roller with scarifier	Jan. 31	Jan. 17
Ontario, Province of, work on provincial highway, Township of Ameliasburg ..	Feb. 10	Jan. 17
Victoria, B.C., fabrication and erection of part of the superstructure of Johnson Street bridge	Feb. 13	Jan. 17

BRIDGES, ROADS AND STREETS

Alberta, Province of.—City Engineer George W. Craig, Mayor S. H. Adams, Commissioner A. J. Samis, and Commissioner Angus Smith, of Calgary, made a strong appeal to Hon. Alex. Ross, minister of public works, that the province rebuild the old Bowness road, between the city limits and the Bowness bridge.

Aylmer, Ont.—The council will petition the Provincial Government for further highway improvements on Talbot St., between that town and St. Thomas.

Birch Cliff, Ont.—Scarboro Township Council decided to cut down a hill on Denton Ave. to provide work for the unemployed. A fill may also be made on Pharmacy Ave. Clerk, W. A. Annis, Scarboro.

Bridgeburg, Ont.—W. M. German, M.P., has gone to Ottawa and will take up with the commission that is now running the Canadian National lines and the Grand Trunk, the question of enlarging the International Bridge here.

Britannia Beach, B.C.—The contract for the rebuilding of the bridge which was carried away in the flood last November has been awarded to Hodgson, King and Marble, of Vancouver, at \$10,000.

Calgary, Alta.—L. C. Charlesworth, of the provincial public works department, and George W. Craig, City Engineer of Calgary, will hold a conference with C.P.R. engineers regarding the replacing of the old wooden bridge over the C.P.R. irrigation canal, on the extension of Seventeenth Ave., by a new bridge.

Chatham, Ont.—A special committee of the Kent County Council, consisting of Reeve Cameron, chairman of the county roads committee; Reeve Ward, of Orford; and Road Superintendent Pardoe, will interview Hon. F. C. Biggs, provincial minister of public works, regarding certain road improvement work for Kent County.

Debden, Sask.—The local board of trade is seeking co-operation with the towns of Polwarth, Canwood, Shellbrook and the city of Prince Albert, to urge upon the provincial government that the Prince Albert-Shellbrook highway be continued north to Debden, and then west to join the old Green Lake trail at Shell River. The distance between Shellbrook and Debden is 31 miles, and there are 9 miles between Debden and Shell River post office.

Hamilton, Ont.—The advisability of diverting the Waterdown road to connect with bridge No. 3 at the western

entrance of the provincial highway system to this city, was discussed by the suburban area commission with Hon. F. C. Biggs, minister of public works recently. Estimates for the work were presented, and there is a strong likelihood that this shortcut will be incorporated in the good roads system. The plan is to build a road from a point near the Jewish cemetery to the provincial road. To do this would require, according to estimates, excavations of 6,500 cu. yds., and a fill of 48,000 cu. yds.

London, Ont.—The Suburban Roads Commission is to be reorganized and new work resumed. First plans are to be laid for continuing the pavement of the pipe line road through from the city limits to Springbank Park. Address Ex-Mayor E. S. Little.

London, Ont.—The works committee decided to carry out all paving work this year by day labor and filed the recommendation of the 1921 works committee that tenders be called on all city works or supplies contracts. Tenders will be called, however, on sewer construction, curbs, gutters and sidewalks.

Montreal, Que.—Work on the plans for the widening and enlargement of the subways on Wellington and Ontario Streets will be commenced immediately.

Ontario, Province of.—It is understood that the Department of Public Highways intends to build about four miles of the Kingston-Ottawa highway this year, commencing at the village of Barriefield.

Ontario, Province of.—A diversion of the provincial highway between Belleville and Picton is being urged by various interests in Prince Edward County, and as a result of representations made to the Department of Highways by Hon. Nelson Parliament, member for the riding, engineers will be sent down to go over the ground and report on the proposal.

Ontario, Province of.—Seeking for an extension this year of road work from Burk's Falls to Magnetawan, a deputation of North country men, headed by Dr. J. J. Wilson, Burk's Falls, waited upon Premier Drury and Hon. Beniah Bowman, and received assurance that as much work as is practicable will be gone on with during the winter.

Ontario, Province of.—A deputation from Elgin County waited on Hon. F. C. Biggs, minister of public works, asking that the provincial highway be continued through from London to St. Thomas, the principal object being to get the highway from Talbotville into St. Thomas, a distance of three miles. It is stated that Mr. Biggs gave assurance that this would be gone on with next summer.

Ontario, Province of.—The Department of Public Highways will shortly call for tenders for the construction of a high-level bridge across the Highland Creek Valley at West Hill on the Kingston Road. The highway will be diverted to a point some distance south of where the present roadway winds down the "S" bend from West Hill, and will cross the valley where it narrows to a width of about 700 ft.

Quebec, Province of.—The Government will construct a bridge across the Gatineau river at Gracefield, work to start early next summer. Chief Engineer, Emile Lemondeau.

Quebec, Que.—Hon. J. L. Perron, Minister of Roads, will call for tenders for the completion of the balance of the Montreal-Mont Laurier highway, a distance of seventeen miles between Montreal and St. Agathe. Tenders will also be called for road construction on the St. Lambert-Levis highway. The section to be built is 28½ miles between St. Lambert and Sorel, and construction will be of gravel and macadam. Another highway which will be built next

summer, and for which tenders will be called by the department within two weeks, is the road between St. Hyacinthe and Rougemont. Tenders will also be called in about two weeks for the building of 25 miles of road between Montreal and Sherbrooks.

Seymour Tp., Ont.—The Township Council plans road work and will probably appoint a road superintendent and foreman for same. Clerk, George A. Hay, Campbell-ford.

Toronto, Ont.—Ward Seven ratepayers are agitating for the preservation of Dundas St. as well as Bloor St. as a provincial highway, with a high-level bridge at the Humber River.

Toronto, Ont.—It is understood that the program for this year of the Toronto and York Roads Commission will be one of the largest attempted in the twelve years the commission has been in existence.

Toronto, Ont.—Dr. Hugh A. Stevenson, M.P.P. for London, accompanied by a delegation representing Huron County, waited on Hon. F. C. Biggs, minister of public works, to urge that the road from Brucefield and Egmont to Wroxeter Station, in Huron County, be taken over as a provincial road and converted into a permanent highway.

Unionville, Ont.—At a joint meeting of Markham and Whitchurch Township Councils it was decided to go ahead immediately with the opening of the Markham-Whitchurch townline. Reeve George B. Padget and Deputy-Reeve W. C. Gohn, of Markham, and Reeve Crawford and Councillor George Leary, of Whitchurch, were appointed a committee to look after the work.

Vancouver, B.C.—The City Council authorized the expenditure of \$4,700 on new trails, to be built on Somerset St., between Finlayson and Tolmie Avenues; on Jackson St., between Finlayson and Dolmie Avenues; and on Lotus St., from Harriet Road to its end. City Engineer, F. C. Fellowes.

Walkerville, Ont.—Mayor C. J. Stodgell has advocated the widening of the Sandwich Street bridge over the Grand Trunk Railway.

Waterloo, Ont.—Waterloo County Council plans to pave the roadway running two miles south of Elmira this spring. County Engineer, Herbert Johnston, 103 Frederick St., Kitchener, Ont.

Windsor, Ont.—The City Council passed a by-law providing for the construction of pavement on Pierre Ave. City Engineer, M. E. Brian.

York Tp., Ont.—The Township Council estimates the cost of constructing a subway under the Grand Trunk tracks, asked for by the residents of Hilbury Ave., at \$50,000 or \$60,000.

WATER, SEWAGE AND REFUSE

Brantford, Ont.—Work on the new \$130,000 trunk sewer system is to be started within the next few weeks.

Brantford, Ont.—The Brantford Township Board of Health is in favor of proceeding with the construction of more sewers as a means of preventing pollution of the Grand River.

Brantford, Ont.—Because of the pollution of the Grand River the Brantford Township Board of Health will send a deputation to the Provincial Board of Health in an effort to secure relief. R. W. Henry of Brantford Township is chairman of the Board.

Chatham, Ont.—The Water Commission has decided to submit to the ratepayers at the next civic election, in November, a by-law to provide for an expenditure of approximately \$600,000 for the construction of a new water works system.

Fort Garry, Man.—On February 7 a by-law will be submitted to the ratepayers of St. Vital School District No. 1024 to authorize the borrowing of \$9,000 for water supply, sewer and general improvements of the school. Secretary-Treasurer, H. D. de Moissac.

Galt, Ont.—The City Council intends to construct sanitary sewers and storm drains on Wright Ave., Todd St., and Dayton St., at a total estimated cost of \$23,907.41.

Galt, Ont.—The City Council intends to construct sanitary sewers and storm drains on the following streets: Dundas, Dumfries, Borden, Grandview Ave., Waterside Ave., and Augusta St., at a total estimated cost of \$33,673.76. City Clerk, Joseph McCartney.

Hamilton, Ont.—City engineer E. R. Gray has recommended to the Board of Control that a consulting sanitary engineer be engaged to assist in drawing plans for the rearrangement of the sewage disposal system.

Hamilton, Ont.—The Board of Control is considering the question of extending the sewage disposal system. City engineer E. R. Gray has recommended the consolidation of the Gage Avenue, Wentworth St. and Ferguson Ave. plants and the installation of modern equipment. Mr. Gray said that the system would have to be extended eventually to take care of the needs of West Hamilton, Mountain Top and parts of Barton below the mountain but not in the city at present. Albion Creek was suggested as a suitable location for one of the new plants.

Hamilton, Ont.—In a report to the Board of Control regarding the condition of the present sewage disposal plants, City Engineer E. R. Gray recommended that the existing plants be modernized and that the Gage Ave., Wentworth and Ferguson Avenue plants be consolidated, the combined plant to be located east of Gage Ave., which would require a considerable alteration in the present sewer system. Mr. Gray stated that he was not in a position as yet to recommend any special system for the handling of the city's sewage problems.

Kitchener, Ont.—A water works line will be constructed from Queen St. to Riverside Terrace.

London, Ont.—The Provincial Government has put through orders approving \$100,000 worth of sewer construction work to be undertaken here at once. City Engineer, H. A. Brazier.

Midland, Ont.—Mayor W. H. Duncan has advocated the construction of sewers in the east and south-east sections of the town, plans for which have been prepared.

Mimico, Ont.—Mayor Doughty has issued orders for the construction of water mains on Dean St.

Mimico, Ont.—The Town Council decided to construct a sewer on Cavell Ave., from Victoria to Albert St., and on Melrose Ave., from Wesley to Grand Ave. Clerk, B. A. Telfer.

Montreal, Que.—Tenders have been received for the construction of sewers in the following streets: Lajeunesse, Mazarin, Roslyn Ave. and Street Cadastral. City Clerk, Rene Banset.

Montreal, Que.—Ten tenders were received by the executive committee for the construction of a sewer on Hochelaga St., between Joliette and Bourbonniere Streets. The lowest tender, \$4,775, was received from A. Thezand, and the highest, 11,500, from U. Savageau. The tenders were referred to A. E. Doucet, Director of Public Works, for a recommendation.

New Westminster, B.C.—Ruskin Operations, Ltd., will apply to the Comptroller of Water Rights for the approval of the plans of the works to be constructed for the diversion of water from Whonnock Creek and Yanaka Creek.

Peterboro, Ont.—The City Council plans the construction of sewers this winter. City Engineer, R. H. Parsons.

Peterboro, Ont.—The section of the Romaine Street sewer from Aylmer St. to George St. is to be rebuilt at a cost of \$9,000. City Engineer, R. H. Parsons.

Peterboro, Ont.—The Board of Works instructed City Engineer R. R. Parsons to have plans and specifications for the proposed sewage disposal plant on the activated sludge principal ordered by the Provincial Board of Health, completed as soon as possible and submitted to the Provincial Board of Health for approval.

Port Credit, Ont.—The council intends to pass the water works by-law at its next meeting, according to Reeve R. M. Parkinson.

St. Catharines, Ont.—According to a statement made by F. A. Dallyn, Provincial Sanitary Engineer, Toronto, a meeting will be held shortly to discuss the immediate de-

velopment of a water works scheme for the municipalities of St. Catharines, Thorold and Merritt, including a filtration plant at DeCew Falls. It is possible that Welland may be asked to join in the scheme.

St. John, N.B.—A bill providing for a sewage district in the Parish of Simonds will be sent to the Legislature for enactment.

St. John, N.B.—An issue of bonds amounting to \$12,000 for fire hydrants in Lancaster Fire District No. 2 has been authorized.

St. John, N.B.—The Committee of the Common Council opened the following tenders for the supply of cast-iron pipe for the water and sewage departments:—S. Norman Sanction, \$55.75, \$55 and \$54.65 per ton for 8, 10 and 12-in. pipe, respectively; Canada Iron Foundry, Ltd. (Vroom & Arnold), \$52, a ton, or \$53.33, including sales tax; B. & S. H. Thompson & Co., Ltd., \$53, \$53 and \$18.50 for 8, 10 and 12-in. pipe per ton; F. Garson, \$38 a ton for 12-in. pipe; T. McAvity & Sons, Ltd., \$53.50, including sales tax; Francis Hankin & Co., Ltd., \$51.25 and \$126.04 for two different grades; Canadian Fairbanks Morse Co., \$172 and \$220.38 per 100 lbs. for two classes of machine-cast pipe. The bids were referred to the city engineer and Commissioner of Water and Sewerage for a report.

Scarboro Tp., Ont.—The Public Utilities Commission will proceed at once with the laying of a number of water mains.

Smith's Falls, Ont.—The Town Council will proceed at once with the construction of a sewer at a cost of \$22,700. Town Engineer, S. B. Code.

Toronto, Ont.—The Board of Control awarded the contract for the construction of a sewer on Woodington Ave. to the Murphy Contracting Co., at \$11,130.

Toronto, Ont.—Contracts for the laying and jointing of water pipes have been let to the Grant Contracting Co., Ltd., Toronto, and Commissioner R. C. Harris.

Toronto, Ont.—A contract for constructing a sewer on Woodington Ave has been awarded to M. J. Murphy at \$11,130. The other tenders offered were for \$29,000 and \$19,400.

Vancouver, B.C.—The water works by-law, calling for an expenditure of \$270,000 on water works and sewage was passed by the ratepayers.

Welland, Ont.—W. E. Forster, city clerk, will call for tenders for the construction of sewers on Garner and Asher Streets.

Welland, Ont.—The City Council may construct a sewer near Garner and Asher Streets. City Engineer, Charles L. Conlson.

Welland, Ont.—In the annual report of the Water Commission to the City Council, Superintendent Milo made the following recommendations: That a system of metering the water be installed; the construction of 6-in. mains on River Road, from Dorothy St. to John St., and on Park St., from South Main to Hester Lane; the extension of the main on State St.; and that the system of mains in the Fifth Ward be somewhat changed, involving the construction of about 1,000 ft. of 6-in. mains and the necessary hydrants.

Whitby, Ont.—The Public Utilities Commission is negotiating with the government with a view to having a larger water works system installed. Chairman, W. J. Luke.

LIGHT, HEAT AND POWER

Brantford, Ont.—A scheme is now before the Water Commission to secure the sanction of the ratepayers for the construction of a new stand-by pumping plant to be run entirely by electricity. Approximate cost, \$200,000 or \$250,000. In addition, it is claimed that an electric generator could be installed in this plant which would in turn supply and sell to the local Hydro Commission a considerable quantity of electricity, enough it is said, to relieve the local Hydro from the necessity of buying a large amount of its required power.

Eastwood Park, Ont.—A committee will wait on the Etobicoke Hydro Commission to apply for Hydro lighting in Eastwood Park.

Fredericton, N.B.—The Provincial Government has sold a bond issue of \$1,890,000 which will be devoted to Hydro-electric development and permanent highways.

Kitchener, Ont.—The Engineering Department of the Hydro-Electric Power Commission of Ontario will install more modern and adequate switching equipment at the Kitchener power station.

Port Moody, B.C.—Thurston & Flavell, Ltd., have awarded a contract to Smith, Robinson & Co., of Vancouver and Victoria, for the installation of a 1,000-kw. generator and the electrification of their mill, at a probable cost of \$60,000.

Toronto, Ont.—The Property Commissioner submitted a report to the Property Committee regarding a proposed new lighting system for the city generally, except in the down-town district. A sub-committee will make an investigation of the situation. The report submitted three different propositions. One is to remove all existing 100-watt tungsten lamps on the streets of the city and substitute therefore 100-watt nitrogen lamps. There are some 46,000 lamps in service. The present rate is \$7 per lamp per annum, and for 100-watt nitrogen lamps the rate would be \$8.50, or a total difference of \$69,000 on the system. This applies to general residential lighting. The other two schemes refer to such business streets as Queen, King, College, St. Helen's Ave., Carlton, Bloor, Dundas, North Yonge and Bathurst streets. To replace the tungsten 100-watt lamps on these streets with 100-watt nitrogen lamps would mean changing 3,012 lights, or an increased cost of \$6.24. The third scheme is to replace these lights with 200-watt nitrogen lamps, and would mean a cost of \$30,120 per year.

Woodstock, Ont.—The officials of East Oxford Township have been notified by the Hydro-Electric Power Commission of Ontario that out of 138 contracts sent in for Hydro power, 130 have been accepted. This means that between 30 and 35 miles of Hydro lines will be constructed on the highways of Oxford Township during the coming summer.

RAILWAYS

London, Ont.—Mayor J. C. Wilson has announced that one of the first acts of the new City Council will be to resume the campaign for the electrification of the London, Huron & Bruce Railway.

Toronto, Ont.—The Hydro-Electric Power Commission of Ontario has been approached regarding the construction of a Hydro-radial line from St. Mary's to Exeter.

Ottawa, Ont.—Notice has been given of applications to be made to parliament at the next session in respect of five railway charters. In each case extensions of time are being asked. The companies applying are: Canadian Pacific Railway Co., in respect to several extensions in the western provinces; the Inter-Provincial and James Bay Co., in respect of a line from the C.P.R. to or near Lamsden's Mills or towards Des Quinze river; La Compagnie de Chemin de Fer de Colonization de Nord for a line from Le Belle to Mont Laurier and Lake Temiskamingue in Pontiac county; the Esquimalt and Nanaimo Railway Co. and the Kettle Valley Railway Co.

St. Catharines, Ont.—A by-law will be submitted to the ratepayers of the Townships of Crowland, Grantham, Humberstone and Thorold, on January 30, in connection with the proposed purchase of the Niagara, St. Catharines & Toronto Railway.

FACTORIES AND LARGE BUILDINGS

Annapolis Royal, N.S.—The contract for repairs and additions to the Court House has been awarded to J. H. Hicks & Sons for \$21,325.

Britannia Beach, B.C.—The following contracts have been let to Vancouver firms by the Britannia Mining and Smelting Co. in connection with the rebuilding of the ore concentrator which was destroyed by fire last spring: For

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Hydro-Electric Developments Near Bathurst, N. B.

Construction Details of Bathurst Co. Ltd. Plant at Grand Falls, Nepisiguit River — Fifteen Miles of Standard Gauge Railway Laid to Work — Power House and Dam of Reinforced Concrete — Transmission Line 19 Miles Long

BY JAMES DICK

Resident Engineer for the Contractors

THE construction work on the Hydro-Electric development for the Bathurst Company, Limited, of Bathurst, N.B., was recently completed and the units installed are in operation supplying power for the saw mills and pulp mill, of that company, at Bathurst.

With the installation of all machinery provided for, the total capacity of the plant will be 13,500 h.p., under a head of 100 ft., and it is understood that the intention of the company is to supply power to neighboring municipalities from the surplus not required by themselves. Little difficulty is anticipated in disposing of the surplus power in the neighborhood and it is expected that there will be an increase in industrial activity now that an ample supply of power is available. A detailed description of the plant and equipment was given in the "Canadian Engineer" of September 23, 1920, but a short description here will not be out of place.

Dam at Grand Falls

The development comprises a reinforced concrete dam and power house built at Grand Falls on the Nepisiguit River, twenty miles from

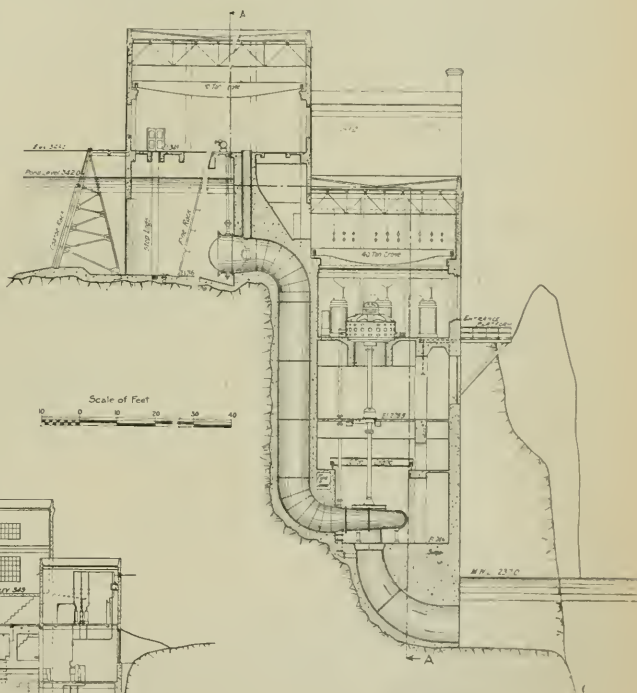


FIGURE 2

the mouth, at which point the town of Bathurst is situated. A stop log dam 305 ft. long, having 9 openings 16 ft. wide, extends across the river at the head of the falls. From this a spillway dam of the O. G. type extends to the power house and in plan is circular, the curve at the upstream face having a radius of 200 ft. A wing wall between the power house and the hill side forms the other side of the forebay.

This construction raises the level of the river above the falls 23 ft. increasing the natural head of the falls to 100 ft. Flood discharge is regulated through the sluices of the dam by timber stop logs bolted together in pairs making a unit 14 in. x 28 in. deep. These are handled very quickly by an electrically driven

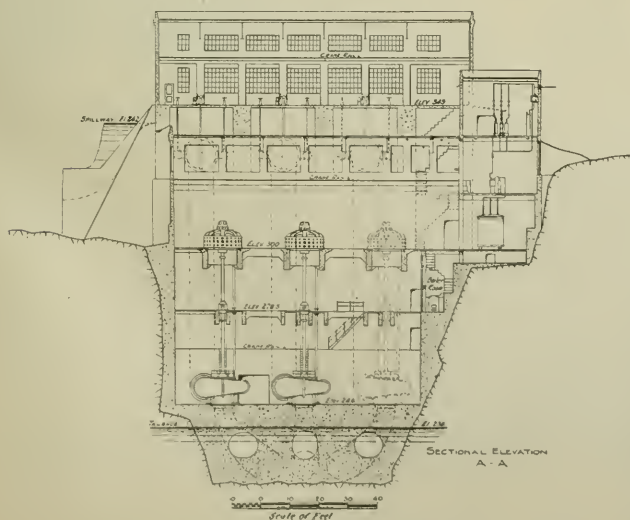


FIGURE 1

lifting machine, the steel stems of which hold the logs from binding during operation. The spillway crest is at Elevation 342, pond level, and the length of discharge is 313 ft. The maximum height of this section is 400 ft. by a width of 38 ft.

Power House and Equipment

The power house is constructed of reinforced concrete and comprises the generator room, transformer room and gate house all under the one roof, the maximum dimensions over all being 93 ft. x 123 ft. The building is situated opposite the foot of the falls and is built on, and into the cliff which at that point is 80 ft. high and practically vertical above the water level.

Space is provided for the installation of three 4,500 h.p. Boving vertical turbines, each direct connected, by a shaft 42 ft. long, to a 3,600 k.v.a. Canadian General Electric Co. 4,400 volt, three phase, 60 cycle generator, operating at a speed of 300 r.p.m. Three 3,600 k.v.a. water cooled transformers are provided for increasing voltage to 33,000, at which it is transmitted. Additional transformers are installed for stepping down voltage to supply power for the operation of motors on pumps, headgates, cranes and also for lighting the plant.

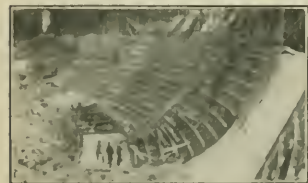
Connection between intakes and turbines is by steel penstocks 8 ft. 6 in. in diameter. The control is at the intake end and is regulated by a butterfly valve operated by motor at the gate house floor. A gravity water supply is installed for serving transformers and the water wheel bearings. Filters are used on the service line to the latter.

Before any construction work could be done it was necessary to lay 15 miles of standard gauge track from Nepisiguit Junction on the Canadian National Railway to the falls. This was laid on the embankment of the Northern New Brunswick & Seaboard Railway, the property of the Canada Iron Corporation, the rails of which had been removed some time ago.

Eighty pound rails were used and laying was done by hand, the material being transferred from steel train, following the laying operations, to lorries. Ties were distributed by wagons and was generally done at night. Owing to the lateness of the season every effort was made to rush this work and including delays and lost time was completed in five weeks.

Topography of Site

The location of the plant and the rugged topography at the site of the work involved features of design and construction which may be of interest. In order to secure the greatest possible head with



SPILLING DAM

the dam as located and designed, the river below the falls was utilized as a tailrace. The falls has a natural head of about 80 ft. and is comprised of three sharp descents the last terminating in a

narrow gorge, the sides of which are from 80 to 90 ft. high rising practically sheer above the water level. To utilize this part of the river as a tailrace it was necessary to excavate into the face of the cliff to provide space for the generating machinery, penstocks and draft tubes.

The excavation was 40 by 87 ft. in plan, at which dimensions it was carried down for a depth of about 80 ft. and a further depth of 22 ft., approximately 30 ft. wide by 60 ft. long, was necessary for the installation of the draft tubes. The side of the excavation was open on the river side down to about four feet above mean water level. It will be noted that the nature of the site presented many problems for the engineers and contractors, more particularly in connection with the construction of the power house but these difficulties were successfully overcome.

The strata of the rock was on an incline with the length of the excavation and at about an angle of 60 degrees with the horizontal. Seams in the rock made it necessary that particular care be taken in the excavation so as to avoid breaking outside the lines laid out for the shaft walls that had to be lined with concrete. The average depth of blasting operations was 12 ft. and forty percent dynamite (Forsite) was used for charges. Ingersoll-Rand drills were used for all heavy drilling and rotating hammer air drills for light work and trimming the sides of the excavation.

Two stiff leg derricks with 60 ft. booms were located at the sides of the cut so as to reach all parts of the work for the removal of the rock without rehandling. As crushed stone was used as concrete aggregate the material from the excavation was deposited by one of the derricks directly to the crusher and the balance dumped in the most suitable place for rehandling to the crusher later. Lack of space for the storage of crushed stone necessitated this, the disposition of excavated material was difficult owing to the steep side hill between the railway and the edge of the gorge.

The steepness of the cliff at the tailrace made it impossible to place a cofferdam so as to unwater the excavation required below the river level for the installation of the draft tubes and the necessary outlet to the river. In order to accomplish this, a section of the rock outside the building line, and extending across the width of the excavation into the cliff, was left intact to act as a cofferdam while the required work was being done. The removal of the natural rock cofferdam presented an interesting engineering feature in this section of the work that it was not accomplished without an element of risk.

Difficulties in Excavation

Careful soundings were taken to determine if the face of the cliff at this point was eroded and undermined by the action of the water. Results showed that the rock sloped gradually to the centre of the pool until a maximum depth of 100 ft. was reached.

This depth made it possible to blast the rock in one shot into the river without fear of blocking the channel.

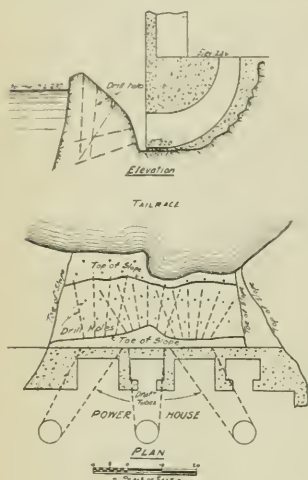
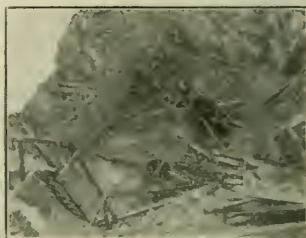


FIGURE 3



Draft Tube and Power House Excavation



Lower Section of Draft Tube and Rock Wall at Tailrace

The incline of the rock across the excavation, deviating from the general direction encountered elsewhere, sloped toward the excavation and a natural retaining wall section was obtained. The maximum head was 20 ft. and contrary to expectation very little seepage occurred.

The sectional elevations of the power house shown in Figures 1 and 2 gives an idea of the size and appearance of the excavation with relation to the building. Before removing the rock left in the tail race the concrete work was brought up to the intermediate floor at Elevation 278.5 and the floor formed.

Figure 3 shows a typical section of the rock wall and the position with relation to the building and also shows the manner in which drill holes were located.

Owing to the narrow section it was impossible to "spring" the holes for heavy charging as there was danger of flooding the area behind the wall before drilling and loading operations could be completed. The holes were therefore spaced, so as to give as good a distribution of the explosive as possible, from 3 to 5 ft. apart with a maximum depth of 18 ft. The lower sets of horizontal holes radiated from the mouth of each of the three draft tubes from which, owing to the narrow space between building and the rock, the drills operated.

Before the charges were fired the openings in the draft tubes were protected and the space in front of the building was filled with water. Over 600 cubic yards of rock was removed and required 850 lbs. of dynamite.

of the shaft up to the main floor level and the penstocks completely enclosed in concrete, which is carried above them forming the breast wall at the intakes.



FOREBAY, SPILLWAY AND POWER HOUSE

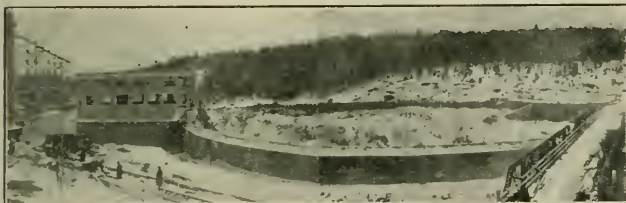
All surface drainage and springs from the face of the rock walls were diverted into a system of box drains fitted to the surface of the rock, and these were connected to a main drain emptying into the tailrace.

To prevent seepage of water from the forebay the foundation under the gate house piers and apron in front of the intakes was carefully excavated to secure bed rock free from seams before concrete was placed.

Each penstock was received in four sections and after each piece was placed the concrete was brought up before the succeeding section was connected. All rivets and connections were carefully caulked and to take care of any possible leakage each penstock was surrounded by a series of weep drains all connected and communicating with the main drain.

The generator floor is of heavy construction, each generator with connecting water wheel superimposing a load of approximately 90 tons. Each unit is carried on two reinforced concrete beams 22 in. wide by 7 ft. 6 in. deep spaced 10 feet apart with a clear span of 24 feet.

A circular wheel pit 10 ft. in diameter is formed be-



VIEW OF POWER HOUSE

Following the completion of this work the building walls of the generator room were built up to the crane beams in order to have the crane installed as quickly as possible for the handling and placing of water wheel equipment, which work was carried on during the construction of the building.

The river is subject to sudden rises at flood water periods and the normal rise below the falls at such times is about 13 ft. making water level 4 ft. higher than the lower floor level. In order to prevent interruption of the work of installing the water wheels, the draft tubes were fitted with timber bulkhead designed to withstand pressure occasioned by any head up to 30 ft.

These were built of 10 x 10 timbers cut to fit the tapered and circular wall of the steel draft tube, and were bolted to the underside of 3 x 3 steel angles fastened around the inside of the tube below the top far enough to be clear of erection operations. In the centre of the bulkhead an 18 in. x 24 in. manhole with watertight cover was provided for access to the underside for caulking and bolting timbers. To prevent a reverse pressure, in the event of a sudden fall in the water creating a vacuum a pipe with a check valve was connected to the bulkheads.

Construction of Power House

The walls of the generator building, with the exception of the downstream wall, are formed against the rock face



SHOWING WATER DIVERTED THROUGH SLUICES

tween the beams, the sides of which with the main beams, provide bearing and anchorage for the generator.

All beams are supported by the mass enclosing the penstocks and on buttress walls at right angles to the downstream wall of the building. These supports extended down to the mass foundation around the draft tubes.

To secure entrance to the generator room for the installation of machinery a roadway was excavated along the top of the cliff from the railway about 500 feet away in order to secure a suitable grade. This terminated at the main door of the power house in a platform 18 ft. wide by 35 ft. long constructed of concrete supported by structural steel beams and struts extending from the wall of the building. The platform is 63 ft. above water level.

With the exception of the section crossing the river channel all foundation excavation required for the dam was in dry land. The material was rock with some overburden of earth. The channel of the river was free from loose material with the exception of some gravel found in deep pockets worn in the rock and an excellent foundation was secured after cleaning.

Unwatering was done in two sections, the first cofferdam being placed from the north shore to mid-stream and then parallel to the flow diverted the water from the site of the north abutment and the two adjoining sluices.

The concrete apron of these sluices was left out so that the water could be diverted through them while construction was being proceeded with across the remaining section of the river bed. A rock reef below this part of the dam was removed to provide a channel for the flow when diverted. The channel closure was made by placing stop logs across

bucket operated by a derrick. Sand was taken from a pit about 1200 ft. away.

Three yard side dump cars of 36 in. gauge were used to transport this to the top of the bins. Cars operated from the pit by gravity and the return was made by cable haul operated by a motor driven hoist located at the pit. Cement was delivered direct from railway cars to a storage building at the rear of the mixing plant.

During a period of the work it was necessary to accept shipments of cement in bulk. This condition not being anticipated, no storage facilities were provided for cement received in this manner. Shipments were therefore arranged so as to have cars arrive during the time in which mixing was being carried on in order that the cement could be sent direct to the mixers. To handle it in this form is was unloaded into boxes each containing the equivalent of one bag and these were placed on a gravity roller conveyor placed between the car and the charging hoppers.

From the sand and crushed stone bins the aggregates were delivered by gravity in chutes to the hoppers above the mixers. Two engine driven mixers each of $\frac{3}{4}$ cu. yd. capacity deposited the concrete into a hoisting bucket by which it was conveyed to the hoppers on the tower above, from there it was distributed by gravity in chutes, one lead-

ing to the power house and another to the dam.

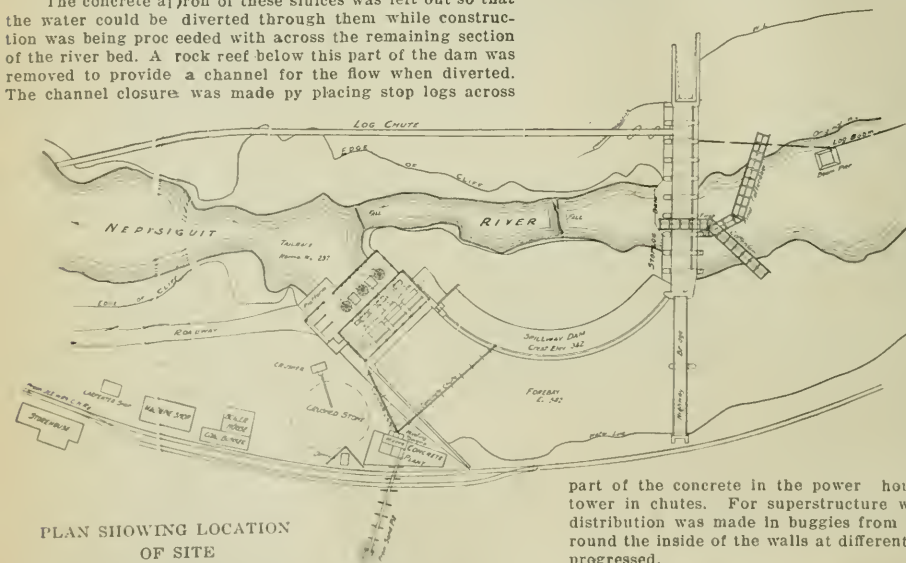
Concrete for the dam was taken from the end of the chute in steel side dump cars of one yard capacity. The narrow gauge track for these was on a trestle above the level of the dam and was extended as the form work progressed. Side chutes were so arranged that concrete could be placed wherever required. Conditions were favorable for placing the greater

part of the concrete in the power house direct from the tower in chutes. For superstructure walls and floors the distribution was made in buggies from platforms placed around the inside of the walls at different stages as the work progressed.

Construction of Transmission Line

The transmission line to Bathurst is about 19 miles long and for 14 miles it is parallel to the railway between the works and Nepisiguit Junction. A single circuit No. 00 B & S standard copper wire is carried on steel poles anchored to concrete bases spaced 400 ft. apart. Standard poles are 32 ft. long built up of 4-2 in. x 2 in. angles spaced 2 ft. 8 in. apart and latticed with 1½ in. x 1½ in. angles. Steel cross arms were provided with top pins for the installation of two circuits. Poles were assembled at the plant and loaded on flat cars for delivery to the various locations along the line. From the end of the railway to Bathurst this work was done by wagons and the poles were generally handled in two sections. Erection was done by block and tackle with gin pole, the only work necessary after pole was vertical being the bolt connections to the angles in the concrete base. Along the railway line an average of 12 poles a day were installed by this method.

At all angles in the line and at important crossings the special towers provided were built up on the site. These are of heavier construction than the standard poles and are anchored to four concrete pedestals.



PLAN SHOWING LOCATION
OF SITE

the openings of the sluices. Projections were built out from the adjoining piers to a height above any water level which might be encountered and the stop logs were held in checks placed clear of the formwork of the sluices.

Cofferdams were built of round timber cribs, rock filled, with two thicknesses of two inch plank on the stream face and a second row of sheeting placed about three feet inside the crib with the intervening space puddled.

Details of Concrete Construction

Concrete work on the spillway dam and the mass foundation of the stop log section was poured in lengths of approximately 50 ft. The vertical joints between the sections were covered with a thickness of tarred felt and suitable keys were formed in the face of the concrete.

Concrete proportions were 1 cement, 2½ sand and 5 crushed stone for all heavy work and 1-2-4 respectively for reinforced. A "Climax" jaw crusher, driven by motor was placed within reach of the derrick removing rock from the power house excavation. The crushed stone was deposited by bucket conveyor into a stock pile, adjacent to the concrete mixing plant, and from there it was transferred to the bins above the mixing room by a one yard clam shell

Copper wire was distributed from a moving train for the transmission line along the railway. Three reels at a time were placed in stands on a flat car at the rear of the train and the wire paid out to the side of the track through snatch blocks on outriggers at the side of the car. After the necessary splicing was done the wire was swung to the cross arms by block and tackle attached to the top of the poles.

The plant was designed by Wm. Kennedy, Jr., consulting engineer, Montreal, the preparation of plans and details of construction were under the supervision of Ernest Loignon who represented him on the work. The work was done under contract by Morrow & Beatty, Limited, Engineering Contractors, Peterborough, Ont., under the direction of L. B. Kingston as general manager. During the time of construction the late Senator Edwards was President of the Bathurst Co., Ltd., and Angus McLean vice-president and general manager.

PRODUCTION OF IRON AND STEEL IN CANADA

The monthly report of the production of iron and steel in Canada for December, 1921, issued by the Bureau of Mines, Ottawa, shows a marked decline in output as well as in prices.

Pig Iron and Ferro-Alloys

The production of pig iron in Canada during December declined to the lowest level for the year, the total pig iron made amounting to only 39,917 long tons, all of which was made in blast furnaces. By kinds of iron produced the outputs for December are as follows: basic, 30,698 tons; foundry, 2,948 tons; and malleable 6,271 tons. Practically all the basic iron was made by the operators for their own further use, only 516 tons being made for direct sale. Foundry iron while showing a considerable decline from the amount produced in November was for the most part made for direct sale, a total of 2,882 tons having been credited to this item during the month. For the first month since August a production of malleable iron was recorded and a total of 6,271 tons was produced for sale.

Ferro-alloys declined from 1,683 tons in November to 846 tons in December, the entire output consisting of the several grades of ferro-silicon.

Two furnaces of the Algoma Steel Corporation which were in blast at the beginning of the month were closed down before the end of the month. The Dominion Steel Corporation also which had two furnaces in blast on December 1, finished up the year with only one furnace working. There were therefore only two furnaces active on December 31st, one operated by the Steel Company of Canada at Hamilton and one by the Dominion Steel Corporation at Sydney. Throughout the greater part of the year at least five furnaces were active, December being the only month in which fewer than five were in blast.

The average monthly output of pig iron in Canada during the twelve months ending December was 50,000 tons, or less than the average monthly record for any year since 1908. Throughout the entire period during which a total of 595,000 long tons of pig iron was made, the market was decidedly quiet and the suspension of interest in iron was general. In the United States as in Canada the final week of 1921 was characterized by a quiet market and declining production. In spite of this there was evidence at the close of the year that there would be an early resumption of activities in the iron trade and the opinion was generally expressed that the first month of the new year would see the beginning of an upward movement in production.

Steel Ingots and Castings

The decline in the output of pig iron during December, and the generally dull market for steel resulted in a marked falling off in the production of steel ingots and castings, the decline from November amounting to more than 30,000 tons. The outputs for the months of November and December were respectively 75,039 tons and 42,653 tons. Of the December output 41,100 tons consisted of basic open

hearth steel ingots made by the producers for their own further use in manufacturing. A total of 1,551 tons of direct steel castings was made, of which 1,458 tons was produced for direct sale, comprising 657 tons of basic open hearth castings, 97 tons Bessemer castings, and 704 tons of steel castings made from electric furnaces. During the month 93 tons of direct steel castings was made by the firms reporting for use in manufacturing in their own plants.

During the twelve months ending December 667,484 long tons of steel ingots and castings was produced as compared with 1,109,000 tons made during 1920. The average monthly production during the year just closed was 56,000 tons as compared with 92,000 tons during the preceding year. Of the total production of steel ingots and castings during 1921, 645,075 tons was in the form of direct steel ingots comprising 641,882 tons of basic open hearth steel, 239 tons acid open hearth steel, 94 tons Bessemer, and 2,860 tons made in electric furnaces. The whole basic and acid open hearth production of steel ingots was made by the operators for the use of their own mills. Of the Bessemer ingots produced 37 tons was used directly and the balance was produced for sale. A total of 2,200 tons of electric steel ingots was used by the plants reporting and 660 tons was made for sale.

Steel castings produced during the year amounted to 22,409 tons, comprising 6,531 tons basic open hearth, 256 tons acid open hearth, 1,638 tons Bessemer and 13,984 tons castings made from electric furnaces. Of the whole amount 18,495 tons was made for sale and 3,914 tons used by the firms reporting. An analysis of the 18,495 tons of direct steel castings made for sale shows 5,031 tons was made by the basic open hearth process, 252 tons in acid open hearth furnaces, 1,401 tons by the Bessemer process and 11,761 tons from electric furnaces.

The low price of steel in December was not only the lowest for the year but was lower than at any time since January, 1916. While the production of steel during 1921 was less than for any preceding year since 1908 the sentiment prevailing in the steel trade at the end of December was favorable to an early resumption of activity and hope was everywhere expressed that the early months of the new year would be marked by a resumption of construction work as a result of the more favorable purchasing market established and that as a consequence a considerable development in the production of steel might be expected.

NEW CANADIAN COMPANIES INCORPORATED IN 1921

AUTHORIZED capital of \$778,173,149 is represented by new companies, incorporated in the first eleven months of 1921, according to "The Monetary Times'" estimate. Companies with Dominion charters constitute \$336,854,650, or about 45 per cent. of the total. Ontario claims about 30 per cent.

The following table gives the details for the eleven months:

Dominion	\$335,854,650
Alberta	17,958,000
British Columbia	74,997,000
Manitoba	32,942,000
New Brunswick	1,135,100
Ontario	239,700,585
Prince Edward Island.....	600,000
Quebec	69,495,499
Saskatchewan	5,490,500
Total	\$778,173,149

There were only six with a capital of \$10,000,000 or over, against twenty during the first eleven months of 1920. The 1921 list is as follows:

Southern Alberta Oils, Ltd., Calgary, \$10,000,000; Harrison Lumber and Pulp Co., Ltd., Vancouver, \$15,000,000; Bathurst Co., Ltd., Bathurst, \$15,000,000; J. E. Booth Co., Ottawa, \$10,000,000; Canadian International Paper Co., Three Rivers, \$20,000,000.

Engineering Institute's Convention at Montreal

Two-Day Session Held Last Week — Combined Annual and Professional Meeting — Reports of Committees and Branches — Presidential Address — Officers Elected—Papers on New Shawinigan Turbine and St. John Bridge

APPROXIMATELY four hundred engineers attended the thirty-sixth annual meeting of the Engineering Institute of Canada, held last week in Montreal. The meeting had been scheduled to be held in Winnipeg, but it was decided a few weeks ago that it would not be advisable to take the annual meeting to the West until next year. Due to the short time available in which to prepare a new program, the Montreal meeting was briefer, more routine and not so well attended as has been the standard in the Institute during the past few years.

J. M. R. Fairbairn, president of the Institute and chief engineer of the Canadian Pacific Railway, called the meeting to order at 10 a.m., Tuesday, January 24, in the assembly hall of the Institute's headquarters building. F. S. Keith, secretary of the Institute, read a telegram from the secretary of the American Federated Engineering Societies, inviting the Engineering Institute of Canada to join the American Federated Engineering Societies. It was decided to discuss the invitation later in the day under the head of "New Business."

Mr. Keith presented the minutes of the last annual meeting of the Institute, held in Montreal, January 25, 1921, and in Toronto, February 1, 1921, and they were taken as read and adopted.

President Fairbairn appointed W. S. Lea and C. K. McDougall as scrutineers to report upon the balloting for officers for the ensuing year.

Upon motion of H. G. Acres, the auditors, Riddell, Stead, Graham & Hutchison, chartered accountants, were appointed for another year.

Report of Council

Secretary Keith read the report of the Council of the Institute for 1921. Three new branches were established during the year: London, Ont., Lethbridge, Alta., and the Cape Breton branch.

"It is undeniable," said the Council, "that the year just closed has been one of the poorest from the viewpoint of engineering operations for many years. It is some satisfaction to note that the outlook for the coming year is more promising."

"The difficulties involved in connection with the work of the Committee on Policy, due to its breadth of scope and the many factors presented to it for consideration, became apparent during the year, and although the Committee has done a great deal of work it has been found impossible to put the result into final shape without a meeting of the committee, and it is therefore recommended to the incoming Council that a meeting be held shortly of the committee."

"Classification and Remuneration have been advanced to a point here the committee's final report is under consideration by Council at the present time, and it is anticipated that this report will be submitted to the various branches in the immediate future, for discussion and suggestions."

Membership of Institute

There was an increase in membership of the Institute of about 15% during the past year, stated the report of the Council, 71 members, 330 associate members, 115 juniors, 347 students and 10 associates having been admitted, while resignations and removals from the roll totalled 16 members, 50 associate members, 71 juniors, 106 students and 10 associates. Death was responsible for the loss of 32 other members of the Institute during the year. At present the membership totals 4,688, including 10 honorary members, 1,018 members, 2,285 associate members, 438 juniors, 899 students and 38 associates; and in addition, 191 mem-

bers of various grades have been elected whose acceptance of membership is still pending.

Finance Committee's Report

R. A. Ross, chairman of the Finance Committee of the Institute, presented the report of that committee, showing \$39,877 income from fees, \$6,204 net profit on publication of the Institute's "Journal," and \$1,416 income from other miscellaneous sources. The expenditures totalled \$37,183, leaving a balance of \$10,313 as surplus of revenue over expenditure. The assets of the Institute now amount to \$115,088, and the liabilities to \$24,333, of which \$22,000 is the mortgage on the headquarters property. The surplus amount stands at \$90,755. It is intended to apply \$10,000 of the surplus for the year 1921 to a reduction of the mortgage on the Institute's headquarters property, which will then leave a mortgage of only \$10,000 outstanding.

Budget Closely Estimated

The year 1921 was the first year during which the financial affairs of the Institute were conducted upon the budget system. The estimated operating surplus appearing in the budget prepared early in 1921 was \$10,468. The actual operating surplus certified by the auditors was \$10,313, or only \$155 less than the estimate, which certainly speaks well for the business foresight and judgment of the members of the Finance Committee.

Committee Reports

Routine reports were received from the Library and House Committee, Legislation and By-laws Committee, Papers Committee, Publications Committee, Canadian National Committee of the International Electro-Technical Commission, Civil Service Classification Committee, Honor Roll and War Trophies Committee, Publicity Committee, Uniform Steam Boiler Specifications Committee and the Committee on International Co-operation.

Walter J. Francis, chairman of the Committee on Legislation and By-laws, stated in his report that the committee had "kept in close touch with the legislation situation throughout the whole Dominion, and confidently believes that the period of evolution through which the profession is now passing will end in the haven of recognition already attained by our sister professions — law and medicine. This end cannot be reached by us, however, until its need is fully recognized by our members, and by everyone engaged in any branch of the profession, as well as by our legislators, and it is more than ever incumbent upon us, each and every one, to act in such a way that the public will appreciate our high ideals and in the end realize the wonderful part the engineer is playing in our great civilization."

In the report of the Canadian Engineering Standards Committee, of which Mr. Francis is also chairman, he states there are now about 250 members on the various working committees of the Canadian Engineering Standards Association. Standard specifications for galvanized telegraph and telephone wire and for wire rope for mining and dredging purposes were issued during the past year, and a standard specification for Portland cement is now in press.

"The following publications," states Mr. Francis, "are in an advanced stage of progress, and will shortly be ready for submission to the Main Committee for authority to print: Reprint of Standard Specification for Steel Railway Bridges; Standard Specification for Steel Highway Bridges; Standard Requirements for A.C. Watt-hour Meters."

"During the last few weeks a number of important suggestions for activity have been received, among which may be mentioned one from the Automobile Club of Canada

requesting the formation of a committee to draw up, if possible, specifications for gasoline, which will be acceptable to, and used by the manufacturers, and one from the Dominion Highways Commission, asking for the organization of a sectional committee on road materials and construction, with the view of obtaining the co-operation of the various provincial highways authorities, engineers and contractors, in defining and specifying road materials and methods so as to avoid confusion and secure uniformity wherever possible in the requirements for this important work throughout the Dominion."

Prof. L. A. Herdt, chairman of the Canadian National Committee of the International Electro-Technical Commission, reported that Canada will probably be represented by Major Edgcombe at the international conference in Paris on technical problems of high-tension distribution.

W. A. McLean, chairman of the Roads and Pavements Committee, submitted a report which appears in full on another page of this issue.

Award of Gzowski Medal

The Gzowski Medal Committee announced its award for 1921 to P. Ackerman for his paper on "Relay Protective Features of the Toronto Transmission and Distribution System." The winner of the student's prize was A. M. Robertson for a paper on "Organization of Engineering Services during the War."

Concrete in Alkali Soils

The Committee on Deterioration of Concrete in Alkali Soils, in a report signed by its secretary, Prof. G. M. Williams of the University of Saskatchewan, announced that a total of \$13,200 had been contributed to the funds of the Committee, as follows: Canada Cement Co. \$3,000, C.P.R. \$1,000, City of Winnipeg \$200, Province of Alberta \$1,000, Province of Saskatchewan \$3,000, and the Research Council \$5,000. Approval was asked of the appointment of Dr. T. Thorvaldson, professor of chemistry at the University of Saskatchewan, as chemist in charge of the committee's chemical research for a period of two years. It was decided to discuss this appointment under the head of "New Business."

C. C. Kirby, of St. John, N.B., requested that the scope of the committee's investigations be widened to include deterioration of concrete in sea water, but it was decided that this could not be done because the committee's funds had been donated for the particular purpose of investigating deterioration in alkali soils; and, moreover, because committees have been at work for years, in the United States and many other countries throughout the world, on the sea-water problem, and it was thought best not to endeavor to duplicate that work but rather to confine the committee's funds and effort to a solution of what is more essentially a Canadian national problem.

J. A. Jamieson said that the trouble in alkali soils is due entirely to chemical reactions, while in sea-water frost is a big item. Both investigations are very important, he said, and any information gained by the western committee should be available at once to the committee of the St. John Branch who are working on the sea-water problem, and vice versa.

Publicity and Legislation

In discussing the report of the Publicity Committee, R. A. Ross urged the publication of more information about engineers and engineering in the daily newspapers. He said that the public should be properly impressed with the fact that there is not a single thing in the way of public utilities or similar advancement that is not due to engineers. He announced that the Research Council intends very soon to send out a series of articles on research in order to endeavor to secure public backing for the movement to establish a research institute at Ottawa.

J. B. Chailles, discussing the report of the Finance Committee, suggested that in view of the large surplus on the year's operations, the loan of \$400 made by Council to the Ontario Provincial Division in connection with ex-

penses re legislation, be considered as a gift instead of as a loan. This request did not meet with much sympathy from the Quebec and New Brunswick members, who appeared to be of the opinion that there are enough engineers in Ontario to be able to finance their own legislation. Ontario engineers pointed out that one-third of the membership of the Institute are resident in Ontario, and that if that province does not adopt suitable legislation for regulating the profession, the progress of legislation in other provinces will be hampered, and that certainly it will not work so smoothly as it would were Ontario well in line. The matter was finally referred to the incoming Council with power to act.

Luncheon at Windsor Station

At 12:30 the meeting adjourned and the members walked to the C.P.R. Windsor Street Station, where luncheon was served in the mezzanine dining room. There were no speeches, but the secretaries of the branches from Sault Ste. Marie to Halifax, nearly all of whom were present, were introduced. At 2:30 p.m. the annual meeting was resumed at headquarters, with H. G. Acres, vice-president of the Institute, in the chair.

Nominating Committee

Announcement was made of the election of the following as members of the nominating committee for the ensuing year: John Murphy (representing the Ottawa and Kingston branches), H. Thorn (Border Cities Branch), G. D. Macdougall (Cape Breton), C. MacN. Steeves (St. John), C. J. Mackenzie (Saskatchewan), J. Muirhead (Vancouver), P. L. Allison (Peterborough), J. A. McFarlane (Hamilton), J. D. McBeath (Moncton), F. W. Alexander (Calgary), A. J. Grant (Niagara Peninsula), William Storrie (Toronto), J. G. Legrand (Winnipeg), F. A. Bowman (Halifax), C. C. Sutherland (Edmonton), B. E. Barnhill (Sault Ste. Marie), A. B. Normandin (Quebec), G. N. Houston (Lethbridge), O. O. Lefebvre and P. B. Motley (Montreal) and K. M. Chadwick (Victoria).

Proposed Amendment to By-laws

Mr. Acres read a petition from the Ontario Provincial Division to amend the by-laws so as to make every retiring branch secretary an ex-officio member of the branch executive for a period of one year following his retirement as secretary. Secretary Busfield, of the Montreal Branch, stated that his branch had discussed the proposed amendment and were opposed to it on the grounds that a very good secretary might make a poor executive official, and also because a branch which desired to get rid of a poor secretary would be saddled with him as a member of the executive for a year. After considerable discussion it was decided to let the proposed amendment take the usual course and be sent out for letter ballot.

Resolutions re Deceased Members

A resolution was adopted expressing regret at the sudden death recently of Eugene D. Lafleur, who was for many years chief engineer of the Department of Public Works, Ottawa. Fitting tributes were paid to his memory by a number of speakers, including Geo. A. Mountain, chief engineer of the Board of Railway Commissioners, Ottawa, who had known Mr. Lafleur for forty years and had been associated with him in many undertakings. Mr. Acres referred to Mr. Lafleur as one who had labored long and honorably in the service of his country.

A similar resolution was adopted in regard to the death of Sir John Kennedy, one of the past presidents of the Institute and the dean of the engineering fraternity in Canada.

Report of Branches

The routine reports of the branches and of the Ontario Provincial Division were received and adopted, and the "New Business" was reached on the agenda of the meeting. The appointment of Prof. Thorvaldson by the Committee on Deterioration of Concrete in Alkali Soils was approved upon the distinct understanding that the Institute

is not to be held liable in any manner for any portion of his salary, which, it is understood, is to be met from the funds already contributed to the committee from other sources.

Recognition Follows Service

There was considerable discussion regarding publicity for engineers in connection with a motion introduced by C. A. Mullen, but no suggestions of any value were forthcoming and the discussion was finally closed by Mr. Acres with the assertion that publicity will follow meritorious work without solicitation, and that if every engineer will do his work to the very best of his ability and do it faithfully and well, that recognition and publicity and remuneration will follow as surely as night follows day.

Election of Officers

The report of the scrutineers, announcing the officers elected for the ensuing year, was as follows:

President—J. G. Sullivan, consulting engineer, Winnipeg.

Vice-presidents—Gen. C. H. Mitchell, dean of the Faculty of Applied Science and Engineering, University of Toronto; and Arthur Surveyer, consulting engineer, Montreal.

Councillors—Geo. McLeod, engineer of sewers, City Hall, Montreal; J. Duchastel, city engineer, Outremont; J. E. Gibault, division engineer, C. N. R., Levis, Que.; A. F. Stewart, chief engineer, C.N.R., Moncton, N.B.; Col. Alex. Macphail, Queen's University, Kingston; R. O. Wynne-Roberts, consulting engineer, Toronto; C. H. E. Rounthwaite, Sault Ste. Marie; Lt.-Col. D. A. Ross, consulting engineer, Winnipeg; Prof. A. R. Greig, University of Saskatchewan; R. S. L. Wilson, University of Alberta; Major Geo. A. Walkem, Vancouver Machinery Depot, Vancouver.

Presidential Address

Mr. Acres called upon the retiring president, Mr. Fairbairn, for the annual presidential address, stating that the pleasure of hearing Mr. Fairbairn's speech would be tempered by a very full measure of regret at his retirement as chief executive officer of the Institute.

Mr. Fairbairn expressed the opinion that the expected reaction from intense war-time activity had reached its maximum, and that business is again on the upgrade, although there must be a further downward trend in the prices of many commodities and a considerable increase in the demand for manufactured products in order to bring conditions back to normal. The decrease in business during the past year had worked a hardship on the younger engineers, said Mr. Fairbairn, but there are now signs of improvement and it remains only for us all to help one another over the few rough spots that may still appear, in order to tide everyone over until we reach the prosperity that must await an intelligent and industrious people in such a young and wealthy country.

The activities of the 22 branches of the Institute constitute the most important phase of its work, continued Mr. Fairbairn, and it is encouraging to note that every branch had held meetings and was active throughout the year, and that all of them had grown in membership. Dr. Geo. Herrick Duggan, upon his retirement from the presidency of the Institute in January, 1917, had exhibited a number of charts showing the increase in growth in membership of the Institute from its organization in 1887 to the end of the year 1916. Mr. Fairbairn said that he had extended the curves plotted by Dr. Duggan to show the figures to the end of 1921, with the following results:

The members increased from 700 in 1916 to 1,000 in 1921; the associate members, from 1,500 to 2,300; the non-corporate members, from 900 to 1,600; the total, from 3,100 to 4,900, or an increase of 1,800, or more than 50% in five years.

Mr. Fairbairn showed a chart of the division of membership geographically. Of the total membership 35% reside in Ontario; 21.5% in Quebec; 8.5% in British Columbia; 6.1% in Alberta; 8.2% in Manitoba; 3.8% in Nova Scotia; 4% in New Brunswick; 3.3% in Saskatchewan; and 9.6% in the United States and elsewhere.

Among the subjects to which attention must be given by the Institute, declared Mr. Fairbairn, are professional ethics, publicity for engineers, enrolment of more student members and a reclassification of members or the organization of additional classes in order to broaden the Institute and take in many men who are not at present eligible for membership in the existing classes.

Expressing regret at the absence of the president-elect, J. G. Sullivan, who was unavoidably detained by important business in Winnipeg, Mr. Fairbairn read a message from Mr. Sullivan reminding the members of the professional meeting to be held in Winnipeg in September, and inviting them all to attend.

Annual Banquet

The annual banquet of the Institute was held in the Prince of Wales Room, Windsor Hotel, and was followed by a smoker and vaudeville entertainment.

Visited Dominion Engineering Works

Special cars left the Windsor Hotel at 9:30 a.m. Wednesday to convey the members to the plant of the Dominion Engineering Works, Ltd., at Rockfield, where they inspected the 41,000-h.p. hydraulic turbine now under construction for the Shawinigan Water & Power Co., and other large machinery now being built at that plant, including the largest Larner-Johnson valve ever constructed, some large newsprint machines and three 30,000,000-gal. single-stage, 240-ft. lift, centrifugal pumps in hand for the city of Montreal.

Romance of Engineering

Luncheon was served in the Rose Room of Windsor Hotel at 1 p.m., followed by an address entitled, "The Romance of Engineering," by Prof. H. E. T. Haultain, of the University of Toronto. The title was, perhaps, somewhat misleading, as Prof. Haultain did not deal with the romance of engineering work but rather with the romance that possibly awaits any young lady who interests herself in the welfare of the young engineers who are graduating every year at McGill, Toronto and other universities. Prof. Haultain's address was modelled closely upon the Sir Andrew Macphail style, and, like the latter's after-dinner speeches, aroused all sorts of comments varying from enthusiastic approval to severe censure.

Julian C. Smith's Address

John T. Farmer, vice-chairman of the Montreal Branch, called the first session of the professional meeting to order at the headquarters building at 3 p.m. Mr. Farmer was chairman of the committee on arrangements for the meeting, and it was largely to his efforts that its success was due.

Julian C. Smith, vice-president and general manager of the Shawinigan Water and Power Co., gave an illustrated address on the new 41,000-h.p. unit now being installed at Shawinigan Falls. The paper was followed by a lively discussion which lasted until nearly 5 o'clock. A report of some of the features of design outlined by Mr. Smith will appear in an early issue of "The Canadian Engineer."

St. John Cantilever Bridge

In the evening it had been intended to have a paper on "Electros and Atoms" by W. B. Cartmel, of the Northern Electric Co. On account of serious illness Mr. Cartmel was unable to be present, and Major Draper, of the C.P.R. Bridge Department, gave an excellent impromptu address on the new St. John Cantilever Bridge. Major Draper's remarks will be fully reported in an early issue of "The Canadian Engineer."

Mimico and New Toronto have a joint water commission and a joint sewerage commission, and it was discovered recently at a meeting of the New Toronto council that Mimico has been buying water from New Toronto for 7 1/2 cents per 1,000 gallons and selling it to the sewerage commission, for which New Toronto pays half the bills, for 15 cents per 1,000 gallons.

SOLVING THE PROBLEM OF ST. LAWRENCE NAVIGATION

Shortcomings of Schemes So Far Proposed — Navigation Value of Side Canals Questioned — Two Stage Development on International Section Favored.

By Chas. P. Loveland

President, Great Lakes & Atlantic Canal & Power Co., Ltd.

FOR many years there have been insistent demands for improved waterway communication on this continent, particularly between the various points on the Great Lakes and the seaboard. The five great inland seas known as the Great Lakes are surrounded by a vast expanse of fertile country, rich as well in mineral and other resources, and capable of supporting an enormous population. Numerous great cities have grown up on the shores of these lakes, and commerce between them is largely waterborne, often in steamers rivalling those of the ocean in size and other essentials. Trade with the outside world, however, must be carried on by aid of either railroads or small canal-size boats to the seaboard, there trans-shipping to ocean carriers, with great attendant expense and delay. This fact has caused much dissatisfaction and public protest. At the same time, certain interests have been working so diligently to obtain the control of waterpowers on the St. Lawrence River, that finally the Canadian and United States governments directed the International Joint Commission, which has control of boundary waters under the Ashburton and succeeding treaties between the United States and Great Britain, to investigate and report on the possibilities of making the St. Lawrence River navigable for sea-going vessels of large capacity from the head of deep water navigation at Montreal to Lake Ontario, as well as those of the development of the available waterpower.

It is a matter of common knowledge that the Commission has held numerous public hearings, where the topic has been freely discussed by many interested parties. As a result, several schemes have been proposed to the Commission for St. Lawrence River improvement, one by the engineers of the Commission itself, and others by various public and private interests. While differing in details, these schemes all resemble each other in the following particulars.

Schemes Proposed

Each scheme provides for an elaborate power development on the International stretch of the river between Prescott and the Quebec boundary at St. Regis. The various deep pools created by the waterpower development are to be connected by locks, thus making this section of the river navigable for deep draught vessels. The cost of this part of the whole project would be apportioned between Canada and the United States, and would undoubtedly be partly repaid in time by receipts from the sale of power.

Various schemes are proposed for the improvement of navigation between Lake St. Francis and Montreal, none of which is adequate for the future demands of transportation, as they all propose tortuous, narrow channels which could only be negotiated by large vessels at a much slower speed than that maintained in the present canals by ordinary canal-size steamers, and even then only with considerable danger both to themselves and to others. Power possibilities in this section of the river, though greater in quantity and closer to markets, as well as more easily and cheaply developed, seem to be relegated to the far-distant future in all these schemes. In at least one of these projects it is even proposed that when developed, the receipts from the sale of power shall be partly applied to the reimbursement of the cost of developing the International section, thereby admitting that the latter project is not self-supporting.

The portion of the St. Lawrence just considered, i.e. that from Lake St. Francis to Montreal, lies entirely in Canada, and it is inconceivable that Canada seriously consider allowing another nation to contribute officially towards the cost of improvements wholly in Canadian ter-

ritory. On the other hand, American citizens will secure the major portion or the benefit to be derived from these improvements, at least for many years, and Canada would hardly be justified in undertaking such an expense in the present state of her finances, nor until her own needs may warrant it.

Outcome of International Development

In the event that the governments of the United States and Canada should commit themselves to one of the schemes proposed, it seems to the writer that the net result would be about as follows:

The hydraulic power of the International section of the river would be fairly well developed.

By the insertion of a few locks in the dams necessitated by this development, part of the cost of construction could be charged against "improvement to navigation," thus ostensibly permitting the electric power to be sold at a reasonable figure.

Owing to the great cost to Canada and the doubtful value to anyone of the navigation improvements proposed below Lake St. Francis, as well as the prevention of power development by private enterprise while the government was committed to one of these schemes, work on this section of the river would be deferred for many years, automatically nullifying the effect of the navigation improvements already referred to on the International section.

In short, the interests which have been agitating for hydro-electric power from the Long Sault would have it supplied to them at a nominal rental, and nobody else would get anything within the lifetime of the present generation.

The writer must not be understood as taking a gloomy view of the possibility and feasibility of navigation for deep draught vessels between the Great Lakes and the ocean. On the contrary, in this article he will outline a project which he and his associates have been studying for many years, which will provide for the reasonable needs of navigation for all time to come. Before proceeding to describe this project, it will be well to state the situation as it is, and the problems to be solved to render it as nearly perfect as is economically practicable.

Existing Situation Analyzed

The territory surrounding the Great Lakes and tributary thereto comprises the largest uniformly productive region of the North American Continent. It now supports a very large population, and can support many times the present number. There is no doubt that this number will be doubled within a very few decades. The products of this great inland empire are greatly in excess of the quantity needed by its inhabitants, and Europe, on account of the requirements of its dense population, offers the best and closest market for this excess production.

While Nature provided these great inland seas capable of carrying a tremendous tonnage, she could only find one route by which their surplus waters could reach the sea. Strange as it might seem, this channel (the St. Lawrence River) coincides with almost the most direct route from the most populous part of the Lake region to England and neighboring European countries. Ocean navigators, whenever possible, when sailing from one port to another, follow the arc of a great circle, as being the shortest distance between the two ports. Were there nothing but open ocean between Lake Erie points and, say, England, the great circle followed by ships trading between them would pass through Lake Ontario and closely approximate the present course of the St. Lawrence River and Gulf.

The quantity of water flowing from the Lakes to the ocean via the St. Lawrence is so great and so uniform throughout the year that it is possible to provide an improved channel capable of carrying ocean steamers of the largest size at regular speed with safety, and at the same time develop a quantity of electric energy probably over half as great as the total so far hydraulically produced in the United States and Canada, from the sale of which a large part, if not all, of the cost of the improvement could be defrayed.

From the foregoing paragraphs the deduction may be drawn that within a comparatively short period of time the demands of commerce as well as those of industry will be so imperative that it will be absolutely necessary to complete the work that Nature has so well begun. By so doing, the needs of navigation will in all human probability be met for all time, as it seems as though ocean carriers had about reached their economic limit of size. It follows that any local improvement work undertaken along the route to be followed by navigation should be so designed and constructed as to form part of one harmonious whole capable of meeting all demands, or it would soon be out of date and would have to be rebuilt at great expense.

It will be possible ultimately to so regulate the level of Lake Ontario as to give a minimum discharge the year around of 225,000 cubic feet per second. On this basis the maximum power development at minimum discharge will total, between Lake Ontario and Montreal, about 5,050,000 h.p. Of this quantity, about 2,050,000 h.p. can be developed in the international river, and about 3,000,000 h.p. between Lake St. Francis and the harbor of Montreal.

Any scheme of improvement to navigation in the St. Lawrence River should recognize the necessity of early regulation of the flow below Montreal. It should also be realized that some time the Ottawa River will be made navigable for large vessels, and suitable provision for the effect of this work on the St. Lawrence should be made.

Proposed New Plan

The writer's proposals for the permanent improvement of navigation between Lake St. Peter and Lake Ontario, stated briefly, include the following major undertakings:

(1) Regulating dam, with lock, across the Berthier Islands, holding the St. Lawrence at about standard high water level. This would do away with all swift currents, as well as future dredging operations, in the St. Lawrence as far as Montreal harbor, and in the Richelieu as far as Chambly Basin.

(2) Improvement of the Richelieu to Lake Champlain.

(3) Navigation and power canal from Lake St. Francis to Chambly, with connection to Montreal harbor. Power can be developed at several locations between Melocheville and Laprairie, or, if conditions warrant, the entire available power of the four rapids can be developed at a point near Laprairie Basin, within ten miles of Montreal, the metropolis and chief industrial city of Canada.

(4) International regulating works near the head of the Long Sault Rapids, with navigation and power canal on the Canadian side, developing the Canadian share of the power available between the Rapide Plat and Lake St. Francis on Canadian soil at Cornwall.

(5) Removal of the Rapide Plat.

(6) International regulating works a short distance above Iroquois Point, with navigation and power canal on the Canadian side, developing the Canadian share of the power available between Lake Ontario and the Rapide Plat on Canadian soil at Iroquois.

By this plan, each nation would have control of the works on its own side of the border, subject only to free use by the other of its navigation facilities.

Apart from the fact that the St. Lawrence River forms the international boundary for a certain distance, its only international feature is the fact that Great Britain and the United States have agreed by treaty that its channels shall be equally free and open to the vessels of both nations. In this connection it should not be forgotten that competent authorities have held that this or any other provision of the treaty could be nullified by the legislative branch of either government. The St. Lawrence is by nature a one-way stream, as no vessels have yet been designed which can climb its rapids, and up to the present all users of the river for upstream navigation have passed through the Canadian channels, which have been equally free to vessels of British or American registry.

The question, however, has now arisen of the adoption of a comprehensive plan of development of the river

to its fullest extent, both for navigation and power. Reference has already been made to the impracticability of joint participation by Canada and the United States in this work where the river flows wholly through Canadian territory, and the present inadvisability of Canada engaging itself to perform it alone as a government project. The reason there given of the expense involved does not of course apply to so great an extent in the International stretch; it does, however, exist in such degree as to warrant limiting the work to be done at joint expense and under joint control to the smallest amount consistent with the full development of navigation and power. We must also always remember that disagreements as to policy, etc., are as likely to arise between nations as individuals, and the uncertain duration of treaties makes it advisable, especially in the case of permanent works, to assign as little as possible of operation and control to joint supervision, and leave each nation as much freedom as possible to carry out its own ideas and designs.

Two-Stage Development Proposed

Various schemes have been proposed, both for single stage and two-stage development of the power or the International river. The writer favors a two-stage development. By carrying out the works at the locations he has indicated there will not only be less interference with existing works and less flooding of valuable lands than by other schemes, but the only joint construction work needed will be the two regulating dams one at the Long Sault and the other above Iroquois. The effect of these dams will be, to state it bluntly, to split the flow of the river in two equal parts, and divert one half to the Canadian side and the other to the American side. Each nation can then exercise absolute authority over the works required on its own side of the river, subject of course to the approval of plans by the International Joint Commission. Navigation canals on the Canadian side will also act as head-races for the Canadian power plants, and undoubtedly locks would be provided in connection with the American power developments as well, thus doubling the locking capacity and providing against congestion and accidents. The two regulating dams of course would have to remain under some kind of joint control, their only function being to adjust, mechanically, as closely as possible, any inequalities in the quantity of water passing on each side of them.

It may seem that the improvement work proposed from Lake Ontario to Lake St. Peter, and via the Richelieu to Lake Champlain, may be resolved into five principal divisions, each of which is a project in itself practically independent of the others, and each of which is believed to have sufficient earning capacity, through the sale of power, to repay the invested capital, with interest, within a reasonable time, besides the ordinary expenses of operation and maintenance.

The five main divisions are as follows:

First Division—Lake St. Peter via the St. Lawrence to Montreal Harbor, and via the Richelieu to Chambly Basin, with incidental power development.

Second Division—Chambly Basin to Lake Champlain; with incidental power development.

Third Division—Montreal Harbor to Lake St. Francis, connecting with the Richelieu near Chambly; with major power development near Montreal.

Fourth Division—Lake St. Francis to Morrisburg, with Canadian power development at Cornwall.

Fifth Division—Morrisburg to Lake Ontario, including removal of the Rapide Plat, channel improvements to Lake Ontario, and power development at Iroquois.

When completed as proposed, the least width of navigable channel will be 600 ft., the least depth 35 ft., and the swiftest current less than two miles an hour. Those dimensions will allow the largest vessels to pass at usual speed, without danger to themselves or others.

Power Company's Plans

The Great Lakes and Atlantic Canal and Power Co., Ltd., which was organized in 1914 under Dominion of Canada

charter for the express purpose of financing means of construction of a deep, speedy, navigable waterway from the Great Lakes to the ocean, has adopted the writer's project in toto. As the Third Division is by far the largest and involves the longest time for completion, besides being contiguous to Montreal Harbor and for that reason naturally the next section for development, it is the company's intention to begin operations in this division, on which it has acquired valuable rights and privileges. Plans are already before the Dominion authorities, for their approval, of a project owned by the company, which will form part of the navigation canal proposed by the writer on this division.

At the same time, it is intended that work shall proceed on all the divisions so that they will be completed practically simultaneously, for obvious reasons. The constantly increasing demands for power lead us to believe that by the time the works are completed, the market will absorb all the power that can be delivered.

It is not within the scope of this brief exposition of the subject of this article, to enter into the maze of technical details, nor even to discuss costs, further than to say that the writer's investigations have convinced him that the work can be completed on the lines as he has recommended at as low a total cost as any of the less comprehensive projects thus far advanced, and with much greater material benefit to all concerned.

In the year 1905 the East Jersey Pipe Company introduced "Lock Bar" steel pipe and since that time this pipe has been manufactured by the East Jersey Pipe Company at its Paterson, N.J., plant. Recently an agreement has

been reached between the East Jersey Pipe Company and the Riter-Conley Company whereby "Lock Bar" steel pipe will hereafter be fabricated in the Pittsburgh district by the Riter-Conley Company at its Leetsdale plant. This arrangement is a decided step forward and will permit considerable saving in freight rates as well as economy in manufacturing. "Lock Bar" pipe has enjoyed an ever increasing demand as a carrier for both water and gas, and in both Canada and the United States the entire water supply of many a community is dependent upon it. The sale of the pipe will continue to be exclusively in the hands of the East Jersey Pipe Company.

Canadian Pacific Railway executives have postponed for several months appropriations for improvement and extension of western lines of the road, according to a statement issued by D. C. Coleman, vice-president in charge of western lines. This is due to present commercial conditions which have imposed a policy of caution with regard to large capital expenditures. Works of urgent character only will be started at present, Mr. Coleman stated, the most important project being the building of a large ocean pier at Vancouver. All extension work on branch lines, which usually is planned at this time of year, is held over for later consideration until indications of a steady revival in railway traffic may become more definitely apparent.

It has been decided to hold the Annual Convention of the Canadian Good Roads Association at Victoria, B.C., on June 13 to 17 inclusive. The convention is expected to be the largest meeting of its kind held so far in Western Canada.

Construction Industries Conference in Hamilton



TWO hundred general contractors, trade contractors, supply dealers and manufacturers met in Hamilton, Ont., January 17 to 20, for the fourth annual conference of the Association of Canadian Building and Construction Industries. A full report of the proceedings at the conference was published in last week's issue of "The Canadian Engineer." The above photograph was taken immediately af-

ter the presentation of the paper presented by Babson's expert on Wednesday morning, January 18. The commodity statistician of the Babson organization had just predicted that the year 1922 will probably show 50% improvement in business as compared with the year 1921, which probably accounts for the good-natured cheerfulness with which the delegates posed for this "flashlight."

SURETY COMPANIES AND CONTRACTORS' BONDS

Obligations Assumed by Surety Companies in Issuance of Bonds Relieve Contractors of Much Responsibility
—How Contract and Bid Bonds are Arranged

By W. H. Hall

General Manager, Canadian Surety Co., Toronto.

THE subject upon which I have been asked to speak, namely, that of contractors' bonds is necessarily one of interest and importance to every building contractor. Because of changed conditions it has become a more common practice in recent years to require that the contractor furnish to the obligee or proprietor, a guarantee bond to insure the performance of his contract or undertaking, in accordance with the plans and specifications, and at the price tendered for. You will be more interested of course, in the practical side of this question rather than the technical and for this reason I have chosen to deal with the former aspect of our topic.

As a preface, however, let us consider what suretyship is and also the responsibility of a surety. Suretyship is the obligation assumed by one known as a surety or guarantor to answer for the debt or default of another. It is older than written history, and suretyship obligations are found among the oldest records of antiquity. As far back as human history goes we find in civilized countries that men in positions of trust, involving the handling of property belonging to others, usually in connection with court proceedings, were required to file bonds guaranteeing that they would honestly perform their duties, and these bonds were given by friends, relatives and others. This requirement was later extended to public officials, to contractors on public construction work, and in other directions. Although the friend risked his possessions, he received no compensation, and frequently had cause to regret that he became surety. At a very early date it became apparent that such contracts must be in writing, unless the way was to be opened to permit gross frauds.

Definition of Surety Bond

What is a surety bond or guarantee bond? A surety bond is a written instrument, except in cases where a recognition in open court is required by law. It is a contract in which usually three parties are interested. The principal, which is the person, firm or corporation that enters upon an undertaking or contract; the surety, is the individual or corporation which guarantees the undertaking or contract of the principal, and the obligee, the one who relies upon the security of the instrument for faithful performance of the principal's undertaking or contract.

What are the responsibilities of a surety and why do individuals rely on the obligations of their friends? Simply as a form they say. If they believed that there was even a remote probability of being called on to pay they would not sign; they would not dare. A debt or an admitted probability of a debt of \$5,000 or \$10,000 to be incurred, without consideration, and unexpectedly, would involve so great a fluctuation and disturbance in the affairs of most men, as to preclude them from the risk; motives of ordinary prudence would prevent even the best-natured friend from becoming surety. Men take those risks because they believe them to be nil. In the great majority of cases the bondsman, if called on, is not able to pay until he rearranges his affairs. Most men have their money tied up in their business or invested in property; the friendly and forgotten bond is without provision, and sales or changes must be made to meet it. So incongruous and so repulsive does it seem that a man should be called on to sign a bond, without pay, which may result in a heavy claim against him, and to which he or his estate at the time of its maturity he is unable to respond, that it is a marvel the custom should ever have obtained, and a greater marvel that business men and courts can still be found who prefer that sort of security to the bond of a surety company. An individual bond cannot, in the very nature of the case, be as good as a corporate bond. The individual goes right on with his busi-

ness and his responsibility is subject to all ordinary mutations. He does not count the bond among his liabilities; he has no income from that class of transactions, and never expects to pay anything on them. Men do not prepare for what they do not expect. On the other hand, a surety company receives an income from the issuance of its bonds sufficient to meet all the claims arising from them; it counts each bond a liability and is compelled by law to make proper provision for it. All its assets are held, not for miscellaneous business, merchandising, speculating, etc., but for the sole purpose of protecting its written obligations. There can be no comparison between the individual and corporate bond in point of safety, convenience or propriety, and we believe that the day is not far distant, if it is not already here, when it will be regarded as outrageous, or out of the common course, to borrow a friend's name for surety purposes, as to borrow his shoes or his clothes for business uses.

Before surety companies were organized, as I have shown, persons signed bonds as sureties for their friends gratuitously, and as a matter of friendship and courtesy, and in many cases without the thought of ever being called upon to pay the obligation. This custom, until the organization of surety companies, was more or less obligatory.

Suretyship Universally Recognized as Necessary

It is noted with satisfaction that corporate or company suretyship is recognized universally as important and necessary, and that one of its chief functions is to relieve the parties between whom a contract of this nature is made, of the obligations incurred as a result of calling upon friends, relatives or business acquaintances, with possible embarrassment later. The friend is relieved of a burden that no sensible reasoning can admit he should ever be called upon to carry. The principal avoids the humiliating position of being forced to seek a surety and of placing himself under obligation in consequence of which he may later on be called upon to pay dearly for the accommodation. The obligee or proprietor is more than satisfied with a bond furnished by a surety corporation whose financial condition is under the constant inspection of the government insurance superintendent, something entirely lacking in the case of the personal surety, who might die or become bankrupt unknown to the obligee, or evade responsibility by transferring his property, or endeavor to compromise when called upon to meet his obligation.

There is a peculiarity in the surety business wherein it is different from other kinds of insurance business. In every other line of insurance the companies engaged in that insurance are the only sources from which that insurance can be obtained. There is not one of you that can insure his life except with a life office, or house against fire anywhere except in a fire insurance company. None of you can procure health or accident insurance except from a company engaged in that business, but in suretyship, if any of you has to give bond, you can go to your nearest neighbor and get that bond from him if you want to, and you might get it for nothing. Any man with a house and a piece of land, or any man with a piece of land without a house can give a bond of suretyship of almost any kind whatever. So that the competition which we have is not the competition alone with other companies engaged in the surety business, but we have the competition of personal sureties all over the country.

Contract Bonds

Coming now to the matter which is of more direct importance and interest to you, namely, that of contract bonds, let us see specifically how closely related suretyship is to the class of business in which you are engaged. If you contract to build a bridge, or to erect any kind of public structure, you must furnish a bond guaranteeing that you, or your surety in case you fail, will complete the undertaking or pay the damages. Are you about to sign a street paving contract? The law requires a bond.

If you have contracted to furnish the government, or municipality or public institutions with supplies of any

description, you will find that one of the conditions of the contract is that you must file a bond guaranteeing that you will fulfil it. No matter what your activity in this respect may be, whether it means erecting buildings, laying sidewalks, constructing roads underground or underwater work, spanning rivers, etc., the community demands that your ability, and financial strength, alone, shall not be relied upon, but back of all this must be the bond of your surety, in case you fail.

Hazard in Issuance of Contract Bonds

Experience has shown and proven that there is a very serious hazard to the surety in the issuance of contract bonds. Many contingencies entirely unforeseen and not calculated against by the contractor may arise in connection with construction work, such as, (a) unusual structural problems, (b) physical difficulties relating to surrounding property which, if damaged in any degree, may bring loss if not ruin upon the contractor, (c) unknown or undiscovered difficulties in the work itself, particularly in underwater or underground contracts, (d) changes and fluctuations in prices for materials and labor, etc.

It is therefore very necessary that the underwriter of contract bonds should possess some knowledge of contracting and engineering; especially is this true in relation to the execution of bid or proposal bonds. When we pass upon an application for a contract bond, (please mark the distinction between a bid or proposal bond and a contract bond), we have before us the copy of the contract and specifications; we know the applicant's financial ability; the experience he has had in similar work; we ascertain the amount of other contracts he has on hand to see if he is trying to do too much business on his capital (a fault not uncommon among some contractors and the cause of most of their failures), but we also have for our guidance the amounts of the proposals of other bidders for the work, and are thus able to see at a glance whether the contractor has made any serious mistake in his estimate.

Then, again, contractors are often required to bid on their own specifications and must guarantee certain results; here again a knowledge of engineering and contracting is essential to serve us in determining the desirability of the risk. When a loss arises on a contract bond, the surety has the right to finish the work itself, to engage someone else to do it on its behalf, or it may abandon the work entirely and let the obligee finish it and charge up the additional cost, if any, against the bond.

There are many and various aspects to be taken into account when dealing with a contract bond application and among others the following may be cited.

1. We must know and carefully consider the practical ability or experience of the contractor in the work which he has undertaken and proposes to perform.
2. His financial responsibility is a vital factor commensurate with the magnitude of the work which he has contracted for.
3. Whether or not he is over-trading is a serious question; that is whether the contractor has too many contracts on hand at the one time in proportion to his financial resources and practical ability.
4. How does his price compare with that of the other bidders. We have found as a general rule that a contractor whose bid is below 10% of the average of all the other bids for work is within the danger line and likely to make a loss rather than a profit on his work.
5. The specifications and contract have to be carefully perused and examined to discover onerous or unfair conditions, if any, imposed upon the contractor. Although the contractor is a party to the contract agreement and must execute same he rarely has any say as to its form, hence the urgent necessity for careful examination of its terms, in order that the interest of the contractor and his Surety may not be prejudiced. No contractor should sign a written party agreement, without perusal or examination of it, simply because it is called "The Contract." The services which the surety company can render in this regard are

valuable to the contractor and are without charge by the surety to him.

6. If the contractor should default how can his surety finish the contract or the reasonable prospect of employing others to do it at a minimum of cost and probably loss.

Bid Bonds and Marked Cheques

The general practice in Canada has been to require bidders to deposit marked cheque for a certain percentage of the amount of their proposal, usually 5% as a guarantee of good faith, the cheques of the lowest and second lowest bidders are usually being retained until the contract has been awarded and signed.

In some instances the municipality, or other body calling for tenders, has not only required the bidder to put up a marked cheque with his tender but has also required him to name, or nominate, his proposed surety, that is to say, the bidder states in his tender whom he proposes as surety for his contract bond in case he is the successful tenderer. While it is customary for a contractor to consult with his proposed surety before nominating it in this manner, it is not absolutely essential for the surety signs nothing, and is under neither moral or legal obligation to execute the contract bond.

Again, some municipalities and boards not only require the giving of a marked cheque but also exact what is known as a "Surety's Consent." This is a separate agreement in the form of tender and calls for execution by the surety and by its terms the surety is bound to execute on behalf of the tenderer whatever contract bond may be required of him if his bid be accepted.

Due to the fact that there is sometimes quite a delay between the opening of bids for any given work and the awarding of the contract, which means that the marked cheques of at least two of the bidders, if not more, are held during this period, resulting in the tying up of the funds of the contractors, or in their having to pay interest to their banks on their marked cheque, there has been more or less agitation of late against the requiring of marked cheques and allowing the substitution of bid or proposal bond as security for tenders. This practice has obtained across the border to a very large extent, it usually being optional in the United States whether a bidder shall give a marked cheque or a bid bond, such being as a definite obligation in a set sum, usually 5% of the amount of the bid, to the effect that if the proposal of the principal on the bond is accepted that he will enter into a necessary contract and give the necessary contract bond within a certain stated period. If he fails to do so the next lowest tender is accepted and the difference between the bids is charged up against the bid bond.

Surety Company Assumes Definite Obligation

In the two classes above referred to, it is to be noted that the surety assumes a definite obligation. As a matter of fact the obligation is often a more hazardous one than the execution of contract bonds themselves, for the surety has not the advantage of the comparative bids in underwriting a bid bond which it usually possesses when giving consideration to the execution of the contract bond.

Notwithstanding this, we frequently find contractors coming in at the last moment, possibly within an hour or half an hour of the time when bids are to be received, and asking that a bid bond or Surety's Consent be executed. In many cases these contractors may have been working on their bids for days if not weeks in advance, yet expect the surety company to render its decision in the matter of giving a bid bond on a few moments notice. We know the work that is to be performed, and what the contractors price is, but unless we have some familiarity with contracting we will have to depend entirely on his figures, to find, perhaps, that he has made some mistake in his estimating or omitted to include the cost of some work he is obligated to do under the contract, and that we have pledged the surety company, that its principal, the contractor will complete the work at his price, or in the event of his failure to do so, that he will pay the municipality or the obligee

on the bond— whoever it may be—the difference between the amount of his estimate, and what it actually cost to complete the work.

The surety company's application form has been arranged as a result of long experience in the business and does not contain any unnecessary query. If the interest alike of the contractor and his surety is to be preserved, and full answers given to the questions asked therein, will insure a quick decision upon the proposal. If information in regard to any question is lacking particularly in connection with the initial application from a builder or contractor, delay is thereby occasioned until particulars are forthcoming. Succeeding applications from the same contractor will probably not require that we obtain all the information necessary in the first instance.

It is therefore expedient, and indeed imperative since the interest of the contractor and his surety are so closely identified, that he should furnish to the surety company, without reservation, a full statement of all facts of which it requires to be informed, in the same way as he would do if making application to his bank for a loan or line of credit. The bond of the surety company is substantially a guarantee of a contractor's reputation, personal and practical, of his credit and also of his financial responsibility.

Consequently it is creditable to the contractor to be able to furnish a corporate surety bond and it should, and very often does, pave the way for preference, to such contractor in his particular line of work. Address delivered at the Annual Conference of the Association of Canadian Building and Construction Industries held at Hamilton, Ont., Jan. 17-20, 1922.

TO DRAFT SPECIFICATIONS FOR ALL TYPES OF ROAD MATERIALS

FOLLOWING is the report which was presented last week to the annual meeting of the Engineering Institute of Canada by the Roads and Pavements Committee, of which W. A. McLean, of Toronto, is chairman.

The year 1921 has been a season of somewhat exceptional activity with respect to road construction and paving throughout Canada; so that the chairman of this committee experienced some slight difficulty in securing the prompt attention of members of the committee whose services would be most valuable. It is anticipated, however, that with the foundation laid during the past year, very satisfactory results will accrue during the year 1922 with respect to the work carried on by this committee.

The committee has undertaken the task of preparing general specifications for various types of roads and pavements and has allocated the drafting of these specifications to various individual members as follows:

A. E. Macallum, block pavements; W. P. Brerton, sheet asphalt; J. A. Duchastel, macadam; W. P. Near, cement concrete; L. C. Charlesworth, gravel; W. A. McLean, bituminous penetration and bituminous concrete.

It is intended that the several specifications will be prepared with some degree of uniformity, based on the following outlines:

- 1—General Description.
- 2—Preparation of Subgrade. (a) Cleaning. (b) Shaping of grade. (c) Consolidating.
- 3—Foundation. (a) Brief description. (b) Dimensions. (c) Materials. (d) Method. (e) Cleaning.
- 4—Blind Course (Cushion). (a) Brief description. (b) Dimensions. (c) Materials. (d) Method..
- 5—Top course. (a) Brief description. (b) Materials. (c) Method of handling. (d) Finishing. (e) Joints.
- 6—Semi Coat (Grouting). (a) Brief description. (b) Materials. (c) Method of handling.
- 7—Shoulders. (a) Brief description. (b) Materials. (c) Method of handling.

Water-Bound Macadam—General description; preparation of subgrade; foundation; top course; shoulders.

Bituminous Macadam, Penetration—General descrip-

tion; preparation of subgrade; foundation; top course; seal coat; shoulders.

Asphaltic Concrete and Sheet Asphalt—General description; preparation of subgrade; water-bound macadam or cement concrete; binder course; top course; seal coat; shoulders.

Cement Concrete—General description; preparation of subgrade; foundation; top course; shoulders.

Brick, Stone, Wood, Asphalt Block—General description; preparation of subgrade; cement concrete; cushion; top course; grouting; shoulders.

COMMITTEES IN CHARGE OF CONSTRUCTION CONFERENCE WORK

MOST of the success of the fourth annual conference of Association of Canadian Building and Construction Industries, which was held in Hamilton, Ont., January 17 to 20, was due to the energetic work performed in committee meetings. The membership of the various conference committees was as follows, the chairman being named first in each list:

LABOR COMMITTEE—J. B. Carswell (Toronto); R. J. Fuller (Toronto); James Mackie (Winnipeg); William Wilson (Regina); J. M. Pigott (Hamilton); J. C. Harris (Halifax); S. E. Dinsmore (Windsor); E. G. M. Cape (Montreal); W. J. Crawford (St. John).

BUSINESS RELATIONS AND STANDARD PRACTICES—Geo. H. Whitlock (Moose Jaw); R. H. New (Hamilton); E. S. Mattice (Montreal); H. J. A. Bird (Moose Jaw); A. J. Bonnett (Winnipeg); A. A. McDonald (Halifax); J. F. Craik (Saskatoon); W. A. Wilson, Regina; John V. Gray (Toronto).

PUBLICITY—E. B. Osborne (Hamilton); F. A. Magee (Hamilton).

FINANCES—J. M. Pigott (Hamilton); E. G. M. Cape (Montreal); A. E. Hamilton (Moose Jaw); John V. Gray (Toronto); A. J. Bonnett (Winnipeg).

CONFERENCE ARRANGEMENTS—F. A. Magee (Hamilton); J. M. Pigott (Hamilton); John Grieve (Montreal); E. B. Osborne (Hamilton).

RESOLUTIONS AND NEW BUSINESS—J. P. Anglin (Montreal); J. M. Pigott (Hamilton); E. S. Mattice (Montreal); John Grieve (Montreal); William Wilson (Regina); Geo. H. Whitlock (Moose Jaw); James Mackie (Winnipeg); J. B. Carswell (Toronto).

PRESIDENT HARDING ENDORSES ST. LAWRENCE SCHEME

IN an address before the National Agricultural Conference at Washington, on Jan. 23, President Warren G. Harding spoke in favor of the St. Lawrence Waterway project. "I have spoken," the President said, "of the advantages which Europe enjoys because of its easy access to the sea, the cheapest and surest transportation facility. In our own country is presented one of the world's most attractive opportunities for extension of the seaways many hundreds of miles inland. The heart of the continent, with its vast resources in both agriculture and industry, would be brought in communication with all the ocean routes by the execution of the St. Lawrence waterway project. To enable ocean-going vessels to have access to all the ports of the Great Lakes would have a most stimulating effect upon the industrial life of the continent's interior. The feasibility of the project is unquestioned, and its cost, compared with some other great engineering works would be small."

The first 55,000 horse-power generator at the Queenston power house went into full commercial operation on Jan. 24. Under the agreement with the companies supplying auxiliary power to the Hydro-Electric Power Commission, a month's notice was to be given of termination of the short-term contract. This power will be discontinued on February 1.

Letter to the Editor

AERIAL PHOTOGRAPHY

Sir: In his letter on "Aerial Photography for Engineers" Canadian Engineer, Dec. 29, Mr. J. C. D. Taylor would have been on much safer ground if he had confined his remarks to the relation of aerial photographs to his own particular business, but when he attempts to show by comparison the superiority of aero-photography to topographic surveying proper, he is floundering out of his depth. In common with most exponents of the aero method he entirely ignores the simplest principles of cartographic projection, and falls into the usual error of confusing a picture with a map. They are two entirely different things. The maps he has evidently been using are reconnaissance or sketch maps which are very often misnamed "topographic" — apparently for the same reason that barber shops are sometimes entitled "Tonsorial Emporiums."

A few companies in the United States are making genuine attempts to use aerial photographs for certain classes of maps, but they are moderate in their claims and do not advertise their work as being superior to large scale topographic maps — on the contrary, they admit that aerial photos cannot take the place of accurate ground surveys.

The complicated and laborious methods of controlling an aerial survey cannot be dealt with in a short article, but with regard to the actual details, readers of "The Canadian Engineer" who are interested can test for themselves the topographical value of aerial photographs by procuring the best possible ones and examining them carefully for the following information:

The natural and artificial features of a country shown on a topographic map by means of conventional signs.

Boundaries: Provincial, county, township, parliamentary, ward, property.

Names of: Provinces, cities, towns, villages, railways, rivers, post offices, public buildings, and all features requiring names.

Roads: Sunk or raised, metalled, asphalt, paved, gravel or clay.

Culverts: Stone, cement, wood, pipe, and water level.

Bridges: Iron, steel, stone, concrete, wood, and elevation of floor above water level.

Railways: Crossings, tracks, embankments, cuttings, milestones, tanks, semaphores.

Buildings, &c.: Ground plan of houses, material (stone, brick, wood); dividing walls in blocks, outside walls, fences, palings, hedges, monuments, arched passages, sidewalks, hydrants, manholes, telephone and telegraph lines, light standards, canal locks, wharves, cranes, mooring posts, drainage openings.

Rivers: Edge of water, high water marks, direction of flow, depth, falls, rapids, fords, ferries, wells, springs.

Pasture land, meadow, orchards, scrub, bush, woods heavy or light timber or mixed).

Marsh, muskeg, bog, sand, reeds, with edges shown.

Mountains, hills, valleys, plains, rolling country. (By means of contours). Bench marks, elevations, trigonometrical stations.

Anybody having the patience to examine the photographs for the foregoing information will be very much disappointed at the results. The next list is even more disheartening because none of the topographical information required can be found on the photos. It is an extract from instructions to topographers working on the One Inch Topo. Map of Canada:

"It is important that the following be clearly shown":

Nature of woods; metalled roads; stone, brick or wood houses; sidings and railway stations; all post offices; telegraph and telephone lines — offices; all culverts over 3 ft.;

elevations of road corners, culverts and bridges; material of bridges; correct names of lakes and streams.

For those of your readers who have not the time nor opportunity to make the above tests, the subject may be simplified by giving an example free from technicalities but still adhering to the principle of the argument. A certain man requires a suit of clothes made to order but is unable to see the tailor about the matter, so he writes to the latter something like this:

Dear Sir: I require a suit of clothes by the 26th inst., but I cannot leave business at present to see you about it. I am sending you, however, a full length photograph of myself from which you will have no difficulty in figuring out the measurements, style, quality of material and amount of cloth required. Trusting to receive same by the above mentioned date. Yours truly,

If any person believes that a satisfactory suit of clothes can be obtained in this way then they must believe that an accurate map can be provided in a similar manner. We have sufficient faith in the public intelligence, however, to believe that both would be voted into the same category as absurdities.

P. J. BARRY.

Winnipeg, Man., Jan. 7, 1922.

STAFF CHANGES OF WALLACE & TIERNAN COMPANY

WALLACE & Tiernan Company Inc. announce the following changes in staff in connection with their various branches. A new office has been opened at 1046 McKnight Building, Minneapolis, Minn., in charge of B. M. Conaty, formerly of their Chicago office. This new district will cover the States of Minnesota, North Dakota, South Dakota, Montana, and the Provinces of Alberta, Saskatchewan and Manitoba.

R. B. Mowry has recently been appointed representative for the company for New Jersey, Delaware, Maryland, (Eastern Section) Districts of Columbia and Virginia and will make his headquarters at the head office at Newark, N.J.

Wallace & Tiernan, Ltd., was recently organized with headquarters at 73 Adelaide St., East, Toronto, this office being in charge of J. Van Benschoten. E. M. Lawson, formerly of the San Francisco office has been become representative at Kansas City, Mo. His district covers the States of Missouri, Colorado, Kansas, Nebraska and Wyoming.

The following additions have recently been made to the company's technical force: S. H. Gregg and G. I. Nelson who will become attached to the Chicago office; A. LoPrest, who will become attached to the San Francisco office; W. Van Benschoten who is now temporarily attached to the Chicago office; R. M. Finch who will, for the present, make the head office at Newark, New Jersey, his headquarters. L. H. Goebel has become Manager of Industrial Sales and R. V. Donnelly manager of Sanitary Sales, both making their headquarters at the main office of the company at Newark, N.J.

THE PACIFIC COAST PIPE COMPANY OF VANCOUVER have just issued their general catalogue which is a very useful and interesting compilation of facts calculated to be of practical value to all those who are concerned with the design, construction and operation of waterworks and hydro electric power plants, etc. It places before engineers, contractors and waterworks men the merits of wood pipe in this connection and in addition includes some very useful tables together with a great many illustrations showing the various uses to which wood stave pipe can be successfully put. This history of the uses of wood pipe is interestingly presented and altogether hydraulic engineers will find in this the newest publication of the Pacific Coast Pipe Company a great deal of useful information. H. C. James, manager of the company, is to be congratulated upon this latest piece of trade literature. The catalogue contains fifty 6 x 9 pages and will be gladly sent to all who apply for a copy.

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RIVAL ST. LAWRENCE WATERWAY PROJECTS

NOW that the report of the International Joint Commission on the St. Lawrence waterway has been referred to the Interstate Commerce Committee of the United States Congress, it is to be expected that a vigorous discussion of the whole proposal will shortly occupy the public attention. Ample stimulus for this will no doubt arise from the objections of New York City and State, as well as from Montreal and such Eastern interests as fear for their existing commercial advantage.

While most of the discussion will probably concern the broad economic features of the situation and the effect upon the commerce of the two countries concerned, there will no doubt be a good deal of attention given by technical men to the engineering features of the various schemes of development proposed. By reason of the great magnitude of the undertaking and because private interests have been concerned with it chiefly because of the power that would be made available, fewer alternative proposals for development were received by the International Joint Commission than might have been expected. Those laid before the commission were submitted by, or on behalf of, the Hydro-Electric Power Commission of Ontario, the New York and Ontario Power Co., Hugh L. Cooper & Co., and E. S. M. Lovelace, of Montreal. Another proposal, outlined elsewhere in this issue, has been put forward by the Great Lakes and Atlantic Canal and Power Co., Ltd.

Extensive reference has already been made in our columns to the proposals of the Hydro-Electric Power Commission with respect to the development of the international section. While several alternative schemes were studied, the one which appears to be generally regarded with most interest, possibly through contrast, is scheme B, which provides for a double-stage development giving an

estimated continuous power output of 1,000,000 h.p. at a cost of \$96 per h.p. or if provision for navigation be included in the power cost, at a cost of \$132 per h.p., including interest during construction. An advantage of this development, as against a single-stage one such as the Hydro scheme A, or that proposed by the government engineers, is, as stated by the proposers, a reduction of the area flooded from 29,000 to 6,000 acres.

Criticism of the Hydro proposals has been made on the ground that the estimates of cost are inaccurate, that the amount of power available is overstated and that no special arrangements have been provided whereby the liability to obstruction of the river by ice jams above Cornwall is overcome. It is stated that the attempt to maintain open water in the reaches between the Galops Rapids and Cornwall might reduce the head at peak in winter from about 70 ft. to under 50 ft. during the existence of an ice jam.

While important differences in estimated costs are to be expected where quantities are necessarily based on preliminary investigations, it is understood that the unit prices assumed by the Hydro were the same as used by the Engineering Board, except in the case of earth excavation within cofferdams, which was higher. Differences of opinion appear to exist concerning the possibility or desirability of attempting to maintain an ice cover in the power reach above Cornwall. Scheme A of the Hydro would be as conducive to the formation of an ice cover as the Wooten-Bowden one, whereas scheme B would be only a little less so, or on the basis of relative areas of open water still remaining in the pools above the dams and power houses, as 11.8 square miles to 9.2. It is doubtful whether with the velocities that will exist above the Barnhart Island plant according to one of the schemes, the maintenance of a very large ice cover is possible, and whether in view of the experiences of the Cedar Rapids Power Co. in preserving an open channel it is desirable to embark on such an undertaking. Apparently, a good deal of further study is necessary with respect to the matter of obstruction, for although the Engineering Board of the International Joint Commission counted upon operating under an ice cover in the power reach above the Long Sault Rapids, the commission in reporting is strongly of the opinion that the ice problem should be gone into very thoroughly by the enlarged engineering board which it recommends.

Rather a large disparity seems to exist between the estimated costs under the Hydro schemes and the scheme of the Engineering Board. Counting provision for 25-ft. navigation with allowance for 30 ft. in the locks, the cost of the Hydro scheme A per h.p. is \$132 and the latter \$109. To render these figures comparable, there should be added to the estimate of the Engineering Board about \$16 per h.p. to allow for interest during construction, bringing it up to \$125 per h.p.

The New York and Ontario Power Co. has proposed a double development scheme which was described in detail in our issue of January 17, with dams at the foot of the Rapide Plat and at the Long Sault Rapids. In accordance with this scheme, which somewhat resembles the Hydro scheme B, it is estimated that 1,655,000 h.p. might be developed and provision for improved navigation be made at a cost of \$87 per h.p. Doubt is expressed by the company concerning the feasibility of maintaining a stable ice cover under the proposed single development scheme of the Engineering Board between the Galops Rapids and Cornwall. Based upon the experience of the company along the river, it expressed the view that it would be better to attempt to maintain an open channel particularly in the lower reaches, and in this view it appears to support the Hydro-Electric Power Commission. The considerably lower cost per unit of power developed is said to arise in part from a somewhat cheaper standard of construction proposed for power houses.

While the above two alternative schemes concern only the international section of the river, that put forward by Hugh L. Cooper & Co. has to do with the entire improvement from Lake Ontario to Montreal. The company estimates that about 1,000,000 h.p. might be developed at its

badly-located Cat Island plant at a cost of about \$200 per h.p. and that 6,625,000 h.p. might be developed along the entire 182 miles at a cost of \$219 per h.p., including necessary provision for deep water navigation.

The proposals of Mr. Lovelace concern chiefly that portion of the river between Montreal and Lake St. Louis. No comprehensive scheme was put forward by him for the undertaking as a whole.

According to the views put forward by Charles P. Loveland, President of the Great Lakes and Atlantic Canal and Power Co., Ltd., the development of the international section would become chiefly a means of providing cheap power for those who have been agitating for hydro-electric power from the Long Sault, and if once the government committed itself to the improvement of this section, the navigation improvements below Lake St. Francis might be deferred many years. This company advocates in addition to certain works below Montreal, a navigation and power canal from Lake St. Francis to Chambly with connection to Montreal harbor providing for power development at several locations between Melocheville and Laprairie. It urges that the only joint construction work undertaken by the two governments be two regulating dams, one at the Long Sault and the other above Iroquois for the purpose of dividing the flow of the river into two equal parts, so that each nation may then exercise absolute authority over the works required on its own side of the river. In this it does not appear to be at variance with the International Joint Commission, which recommends a very similar procedure.

Some of the views expressed by Mr. Loveland will no doubt be challenged by those who favor a development such as that proposed by the Engineering Board and by several others who have submitted alternative schemes. It can scarcely be said that the United States is asked to contribute to improvement of navigation in Canada any more than Canada is being asked to contribute to similar improvements in American waters, nor can the enterprise be attacked on the ground that Canada should not enter it, since American citizens may secure the major portion of the benefit to be derived for some years to come. The report of the International Joint Commission clearly recommends that the expense as far as navigation is concerned, be met in proportion to the benefits derived, and that power works be built, installed and operated at the expense of the country in which they are located.

In such discussions as occur on the engineering features of this great undertaking, it should be remembered that proposals so far put forward have of necessity been based upon a somewhat hurried study of the situation. The twelve months allotted to the Engineering Board made it quite impossible to design the required works in detail or estimate costs in any other manner than by a block system. The same is no doubt true of the estimates made by those who submitted alternative proposals. While there is some discrepancy in the costs of the work in the international section as estimated by the several groups of engineers that have studied the development of this section, it appears that the work involved would not impose an undue burden upon the people of either this country or the United States, even assuming it were not revenue producing. When the revenue from the sale of power is considered, it is seen that at any reasonable cost the development of the waterway would be an economically practicable one.

STRESS DETERMINATION BY POLARIZED LIGHT

AT THE recent meeting of the American Association for the Advancement of Science in Toronto, Dr. Paul Heymans showed in a very striking manner the possibilities of secondary stress determination in complicated structures by the use of polarized light. Until now it has been necessary to attack a problem of this sort with very unwieldy tools, so that the detailed analysis of such stresses in complicated structures has been a labor to be dreaded by engineers. It now appears, however, that by working with models constructed with a transparent substance having satisfactory

optical properties, the distribution of stresses can be strikingly shown by the graduations of color recorded on a photographic plate. By purely optical means, the difference in principal stresses in the specimen may be determined, and the sum of the principal stresses having been found by measurement of the lateral strain, it thus becomes possible to fix the value of the principal stresses and hence the stress in any direction. From certain photographs exhibited by Dr. Heymans, it appears that we may look forward with some confidence to the determination of secondary stresses at rigid joints of a truss by means of polarized light studies. So promising is this field, that every encouragement should be given to research work in it.

PERSONALS

J. W. SMART has been elected president of the Manitoba Association of Architects.

CONTROLLER W. W. HILTZ, of Toronto, has been appointed the representative of the city of Toronto on the Town Planning Association.

BERT DOERR, Kitchener, has been appointed superintendent of the Galt local Hydro Commission and will enter upon his duties Feb. 1st.

C. E. FRASER has been appointed road superintendent for Scarborough Township. It is understood that the new township council is planning extensive road improvements during the coming season.

ALFRED DRYLAND, M. Inst. C.E., County Engineer of Middlesex, England, who paid an extended visit to Canada and the United States last fall wrote recently to "The Canadian Engineer" saying that he has over \$10,000,000 of road and bridge work on hand at the present time.

J. EMILE VANIER, civil engineer, of Montreal, has just returned from Europe where he spent two months visiting various countries for the purpose of ascertaining what European Governments were doing along the line of furnishing farmers with limestone dust for fertilizing purposes. Upon investigation he found that in Europe much more interest is taken in this matter than in Canada. Mr. Vanier is preparing a report on the subject to submit to the Quebec Provincial Government.

J. B. CARSWELL who was recently elected to the Presidency of the Association of the Canadian Building and Construction Industries received his training as civil engineer at Glasgow (Scotland) University of which institution he is a graduate. He came to Canada twelve years ago and engaged in general contracting work in Montreal. He later changed to the engineering staff of the Grand Trunk Railway, following which he represented the firm of Ross, MacDonald and Co. in Ontario for a period of five years. During this period Mr. Carswell had under his charge the erection of the Royal Bank Building, the Central Technical School, the new Union Station, etc. At the outbreak of war he became chief engineer of the Aviation department of the Imperial Munitions Board. While with the Board he built all the flying camps in Can-



ada using his own designing and construction staff. The Carswell Construction Company of Toronto of which Mr. Carswell is president is well known in all parts of this country.

JOHN G. SULLIVAN, consulting engineer, Winnipeg, Man., was elected president of the Engineering Institute of Canada at the annual meeting in Montreal last week. Mr. Sullivan was born at Bushnell's Basin, Munroe Co., New York, on January 11, 1863. He was educated at Cornell University, graduating 1888. His first railroad



experience was with the Great Northern Railway, as rodman, later becoming assistant engineer of that road. In 1893 he became assistant engineer of the Alberta Railway & Coal Co.; locating engineer of the Butte Anaconda and Pacific Ry. 1894; principal engineer Kalso and Slocan Ry. in 1895; reconnaissance engineer Columbia & Western Ry. in 1896, and in 1898 was appointed assistant engineer of this road. In 1899 Mr. Sullivan joined

the engineering staff of Canadian Pacific Railway, being appointed divisional engineer of construction, which position he held until 1905 when he became assistant chief engineer of the Panama Canal. In 1907 Mr. Sullivan returned to the C.P.R. as manager of construction, Eastern lines and in 1908 was appointed assistant chief engineer, at Montreal, holding this position until 1911, when he became chief engineer of Western lines. In 1915 he was appointed chief engineer of the C.P.R., which position he held until his resignation in 1918. Mr. Sullivan is a prominent member of the American Railway Engineering Association. He was chairman of Committee No. 16 Economics of Railway Location and was president of the Association in 1918. Mr. Sullivan is a member of the American Society of Civil Engineers, and has been a member of the Engineering Institute of Canada since 1900.

OBITUARY

ANTON BERG, Toronto, who was a well known inventor of brick making machinery, died last week in his 65th year.

WILL HOLD BUILDING TRADES EXHIBITION IN MONTREAL

AT THE annual meeting of the Builders' Exchange held in Montreal on January 23, a plea was made for the general support and participation by members of the Building Trades in Montreal, in a Building Trades Exhibition, to be held in the Dubrule Building, Phillips Place, on April 1 to 8, inclusive.

The purpose of the exhibition is to awaken prospective builders to the fact that the coming months will be the right time to build, and with this end in view the slogan: "If you are going to build, build now," was adopted as the most suitable to arouse public interest in the project. Mr. Harry Gustin and Lt.-Col. K. C. H. Monks addressed the meeting at length on the benefits to both the builders and the public to be gained by making the exhibition a success.

About 120 members of the Builders' Exchange were present at the annual meeting and at the dinner which preceded it. Before the commencement of business Col. E. G. M. Cape, gave a report of the proceedings at the conference of members of the Association of Canadian Building and Construction Industries held recently in Hamilton. There was a general feeling at the conference, said Col. Cape, that building costs were going no lower. There was a shortage

of building all over the country, and also a very small surplus of building materials, and it was believed that any considerable demand would be likely to keep up the cost of materials.

D. K. Trotter, general secretary, presented the annual report of the secretary-treasurer. This showed total receipts of \$5,473.60, which included the sum of \$299.60 carried forward from 1920, and disbursements during the past year of \$5,470.33. This left a net bank balance of \$3.27.

The officers elected for 1922 were: K. D. Church, president; Douglas Bremner, first vice-president; H. Vincent, second vice-president; A. T. Alexander third vice-president; Alphonse Gratton, fourth vice-president; J. E. Walsh, honorary treasurer; A. Plomondon, honorary secretary. The other directors elected were John Quinlan, E. B. Evans, D. A. Bethune, J. W. Graham, A. W. Bremner, J. D. Johnson, T. Latourelle and A. Leclaire.

MANITOBA ASSOCIATION OF ARCHITECTS ANNUAL MEETING

AT the annual meeting of the Manitoba Association of Architects held last week, J. W. Smart was elected President, G. W. Northwood, vice-president, with the following members of the Council, C. S. Bridgman, C. C. Chisholm, Chivers J. Halley, E. Proin, D. A. Ross and J. M. Semens, Secretary-Treasurer, E. Fitz Munn.

At the meeting it was announced that the Royal Architectural Institute of Canada had expressed a desire to hold its 1922 convention in Winnipeg and a cordial invitation was extended to have them do so.

A resolution was passed commending the action of the Provincial Government in appointing a town planning controller and in putting into operation the town planning act.

POWER LINE FROM NIAGARA TO MONTREAL

AN interesting address was delivered by T. N. Hogg, of the engineering staff Ontario Hydro-Electric Commission on Jan. 27 before the Hamilton Branch of the Engineering Institute of Canada on "St. Lawrence River Power Development." Mr. Hogg predicted that in time a power line would loop Lake Ontario from Niagara Falls to Montreal, the power lines of the St. Lawrence, Trent Valley and Niagara Falls being linked in one great trunk line, from which secondary lines would be served. Since 1905, by the development of Hydro power, a demand for half a million horsepower had been created. The speaker dwelt on the feasibility of the plan and stated that by harnessing the St. Lawrence 35 million tons of coal would be saved yearly by steam power plants. The speaker illustrated his remarks with lantern slides.

In connection with the much discussed question of the electrification of a number of branch railways in Ontario, some interesting conclusions are set forth in the report of the International Joint Commission. The report states that in the zone considered from Lake Erie to the Quebec boundary there are 36,000 miles of railway on both sides of the line. Of these railway lines, 19,000 miles could be electrified profitably. The report says the saving in coal by such an electrification would be 8,890,200 tons annually. These 19,000 miles of railway would cost \$560,000,000, based on costs of 1919, but the annual saving would be \$81,000,000, or 14.2 per cent. on the investment. It is added in the report that the cost today would be nearer \$400,000,000 than \$570,000,000. Whether Canada and the United States are prepared to go ahead with the immense St. Lawrence scheme or not, the figures and comparisons gathered by experts are illuminating in these days of Government economy. To show what coal costs railways in this country, only two years need be cited. In 1919 the Canadian Government C.N.R. lines spent \$2,800,383 for coal; in 1920 the bill was \$3,066,344. In 1916 the average price was \$3.65 a ton, while in 1920 the average price was \$7.40 a ton.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

Construction news items, including notes of various tenders called, are published on pages 44 to 50 of this issue. The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported on the above-mentioned pages. The word "Issue" refers to the issue of "The Canadian Engineer" in which there appeared a notice giving some details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Toronto, Ont., office building, Toronto Hydro-Electric System	Feb. 1	Jan. 24
Windsor, Ont., one motor-driven street flusher	Feb. 7	Jan. 24
Quebec, Province of, construction of gravelling in parish of Ste. Rose du Degele	Feb. 9	Jan. 24
Ontario, Province of, Work on Provincial highway, Township of Ameliasburg ..	Feb. 10	Jan. 17
Victoria, B.C., fabrication and erection of part of the superstructure of Johnson Street bridge	Feb. 13	Jan. 17
Ontario, Province of, supply of Portland cement	Feb. 14	Jan. 24

BRIDGES, ROADS AND STREETS

Birch Cliff, Ont.—It is understood that Scarboro Township Council is planning extensive road improvements, but that the year's road program has not yet been mapped out. Road Superintendent, C. E. Fraser.

Bramford, Ont.—The City Council gave the \$40,000 debenture by-law for the completion of St. Paul's Ave. subway its third reading.

Brantford, Ont.—Estimates for an expenditure of \$62,000 on the suburban section of the Brant County road system will be submitted to the council by the chairman of the Suburban Roads Commission.

Brantford, Ont.—Woodhouse Township, Norfolk County, has asked Brant County Council for aid in presenting the claim for a provincial highway from Port Dover to Guelph. Brant Chamber of Commerce obtained indorsement of the Western Ontario United Boards of Trade at Woodstock recently to a resolution along this line.

Chatham, Ont.—Judging by the way deputations have been appearing before the Kent County Council this session, the good roads movement is still a popular one. On Jan. 26 no fewer than three waited on the Council from various parts of the county urging the construction of permanent roads.

Galt, Ont.—At a recent meeting of the Suburban Road Commission estimates amounting to \$22,500 were prepared for this year's work. This money will be expended in construction work on: No. 12, Blair road; No. 31, Roseville road; No. 33, Sprague's road; No. 35, East River road; No. 37, Toll Gate east; No. 76, Hespeler, Provincial-County between North Dumfries and Waterloo; with a sum for coating some parts of the system with tarvia.

Kingston, Ont.—The Frontenac County Council has decided that during this year the sum of \$109,700 would be expended on its roads. Besides this amount \$16,000 will be expended upon the Kingston suburban area, of which the city of Kingston pays one-half.

Montreal, Que.—Five tenders were received by the Executive Committee for the furnishing of 40,000 ft. of

straight limestone prepared for curbing, and of 5,000 ft. of circular. The highest tender for the former was received from Joseph Brien, at \$1.90 per ft., and the lowest from Georges Labelle, at 95c per ft. For the circular stone, Joseph Brien was again the highest tenderer at \$2.15 per ft. and G. Labelle the lowest at \$1.10. Two tenders were received for granite, Joseph Brunet being prepared to supply 20,000 ft. of straight and 5,000 of circular at \$2.25 and \$3.00 respectively, while the Morrison Quarry Co. can supply the same for \$2.00 and \$2.75, respectively.

Ottawa, Ont.—The Board of Control decided to proceed with the grading of Byron, Java Iona, Parady, Geneva and Clarendon Streets, at a cost of approximately \$12,000.

Ottawa, Ont.—The Suburban Road Commission plans the following work for this year: The rebuilding of the Russell Road for several miles, the extension of the Richmond Road, and some work on the Metcalfe Road. Chairman, John Bingham.

Paris, Ont.—The final plans for the proposed new highway are nearly completed. Clerk, C. B. Barker.

Paris, Ont.—Final plans for the construction of a highway through Paris are under way and work will start in the near future. About 150 men will be employed.

Peterboro, Ont.—City Engineer R. H. Parsons was instructed by the Board of Works to obtain prices on road oil.

Quebec, Province of.—Hon. J. L. Perron, Minister of Highways, informed a delegation from Lotbiniere that work would be resumed in the spring on the Lotbiniere section of the Levis-St. Lambert highway. The work in this section will cover 30 miles.

Quebec, Que.—Hon. J. L. Perron, Minister of Roads, has announced that \$5,000,000 will be expended on new road construction this year, and \$2,500,000 for repairs and maintenance. A new road will be constructed from St. Lambert of St. Hyacinthe, via the Cote Noire Road to the Salaberry monument at Chambly Basin.

Sarnia, Ont.—At the request of the ratepayers of Somers Township, the County Council has decided to build one and three-quarter miles of permanent concrete road on the 16th sideroad to link up with a permanent highway in Kent County.

Todmorden, Ont.—The proposed Todmorden-Leaside bridge was discussed at a recent meeting of the ratepayers. Frank Barber, Engineer, submitted estimates and told how the cost would be met. A committee was formed to interview Leaside ratepayers and the Danforth Business Men's Association with a view to getting their co-operation.

Toronto, Ont.—The City Council referred back for further consideration the proposed widening of Yonge St. from Lawton Ave. to the C.P.R. tracks.

Toronto, Ont.—The City Council gave two readings to the by-law for the extension of Dundas St. across Yonge St. to a point just east of Victoria St.

Toronto, Ont.—Mount Pleasant Ratepayers' Association passed a resolution that deputation should wait on the Board of Control to ask that the Avoca Vale bridge in Moore Park be built at once.

Toronto, Ont.—The City Council intends to construct asphalt pavements on Avenue Road, Gloucester St., Grange Road, John St., Pembroke St., and St. Clair Ave., at an estimated cost of \$227,305. Also a concrete sidewalk on Windermere Ave., at a cost of \$305.

Toronto, Ont.—The proposition of a bridge to extend from the head of Pape Ave. to make connection with the town of Leaside, came before the York County Council at a recent meeting, and the matter was referred to the Warden

and commissioners for report at the June session of the Council.

Toronto, Ont.—Works Commissioner R. C. Harris reported to the Board of Control that he had received a communication from Chief Engineer F. A. Gaby, of the Hydro-Electric Power Commission of Ontario, directing attention to the possibility of the construction of a subway for street cars at Bay St. in the near future.

Toronto, Ont.—Reeve William Keith and J. M. Guardhouse, members of the Toronto and York Roads Commission, submitted to the York County Council a program of road construction involving an expenditure of over \$800,000, including the following: Paving Yonge St. through Richmond Hill after the tracks are moved to the centre of the roadway, \$16,500; widening bridges in Aurora, \$7,000; widening and resurfacing Kennedy road at Unionville, \$58,000; two miles waterbound macadam pavement on Kennedy road north from Casnel, \$33,000; $\frac{1}{2}$ -mile waterbound macadam east of Stouffville, \$12,000; diversion through Ballantrae swamp, \$11,000; grading and gravelling 5th concession, Witechurch, \$4,000; Dundas street culverts, \$800; widening and resurfacing Vaughan road in York township, \$31,900; extending waterbound macadam on Vaughan road in Vaughan, \$38,000; paving stretch of Weston road after tracks moved to centre of street, through Mount Dennis, \$23,000; waterbound macadam from Kleinburg north on Weston road, \$38,000; widening and resurfacing Don Mills road from Pape avenue to Taylor's Hill, \$19,400; extending waterbound macadam on Don Mills road, \$24,000; two miles waterbound macadam, Malton road, \$48,000; Malton road, Eagle street to the Humber, \$8,500; King road, $\frac{1}{2}$ -mile north from King City, waterbound macadam, \$10,960; $3\frac{1}{2}$ miles of concrete pavement on Sutton road from Keswick, \$120,000; waterbound macadam two miles north from Sharon, \$42,000; Mount Albert bridge, \$8,000; Lloydtown road, west of Aurora, two miles waterbound macadam, \$38,000; two miles gravel from Kettleby west, \$8,000; Vandorf road, Wellington street, Aurora, widening and surfacing, \$23,000; York road, Lansing to Oriole, concrete base, hot top, \$40,000; O'Sullivan's corners, one mile west, waterbound macadam, \$22,000; bridge east of Agincourt, \$10,000; Brown's road two miles waterbound macadam, \$42,000; Scarlett road, St. Clair avenue, north $\frac{1}{2}$ -mile, \$15,000.

Winnipeg, Man.—The City Council intends to extend Wolever Ave., from Erin St. to Clifton St., at a cost of \$2,275. City Clerk, C. J. Brown.

WATER, SEWAGE AND REFUSE

Brantford, Ont.—The Board of Works recommended that the offer of Canada Lock-Joint Pipe, Ltd., for the supply of reinforced concrete pipe to be used in the construction of the Mohawk St. outfall sewer, be accepted at the following prices: 36-in. pipe, \$4 per ft.; 42-in. pipe, \$4.75 per ft.

Eastview, Ont.—The Town Council intends to construct a sewer on the Montreal Road, Dora St., Main St., King St., and John St., at an estimated cost of \$70,500. Town Clerk, Joseph Emond.

Port William, Ont.—The City Council will consider two schemes for the construction of a sewer to serve the proposed Wayland school. One scheme for permanent work calls for an expenditure of \$25,000, and the other for temporary connection, costing \$2,000. City Engineer, C. B. Symes.

Kitchener, Ont.—Plans have been completed for the proposed new water works plant to be installed by the Water Commission, and work will commence early in the spring. Superintendent, M. Pequegnat.

Kitchener, Ont.—The Horton Steel Works, Ltd., Bridgeburg, Ont., have been awarded a contract by the City Council for the construction and erection of a standpipe having a capacity of a million Imperial gallons, to be used in connection with the city's water works system. This tank will be 94 ft. in diameter by 23 ft. 3 in. high. The city also considered the advisability of installing a concrete

tank, but after going into the matter carefully, decided on a steel tank as being the best installation.

Midland, Ont.—The Town Council is considering the construction of a sewer on Dominion Ave. at a cost of \$1,600. Clerk, C. E. Smith.

Oil City, Ont.—The Canadian Oil Companies, Ltd., are planning to erect a filtering plant at a cost of \$25,000. The contract for the supply of brick has already been let to Fred Howlett & Sons.

Port Credit, Ont.—Preliminary work for the new water works system will be rushed through in order that active work may be commenced in the early spring. The whole system is estimated to cost \$110,000—\$60,000 for the central plant and \$50,000 for the distribution system.

Prince Rupert, B.C.—The City Council plans the construction of an incinerator early this year. Estimated cost, \$15,000. City Engineer, F. G. Whittaker.

Smith's Falls, Ont.—The Provincial Board of Health has served notice on the town that it must reach a definite decision before February 1 regarding the installation of a filtration plant for its water supply, or suffer the penalty imposed by law. The water supply is now secured from the Rideau river.

Todmorden, Ont.—The proposed improvement of sewers was discussed at a recent meeting of the ratepayers. R. O. Wynne-Roberts, Engineer, outlined a scheme which would cost approximately \$900,000, but stated that for present needs only a small portion of the system, costing about \$90,000, would be necessary.

Toronto, Ont.—City Council referred back a motion by Ald. Baker that the East Toronto water works plant, which is used as a steam reserve, be electrified.

Toronto, Ont.—Works Commissioner Harris will shortly present to the Works Committee a general plan for the construction of a sewage system for the whole of North Toronto.

Toronto, Ont.—The City Council intends to construct water mains on Bedford Park Ave., Brookdale Ave., Cranbrook Ave., Deloraine Ave., Indian Grove, and Lawrence Ave. West, at a cost of \$18,469.41.

Toronto, Ont.—Works Commissioner Harris has recommended the construction of water mains on the following streets: Melrose Ave., Small St., Willard Ave., and Woodbine Ave. Total estimated cost, \$5,870.78.

Toronto, Ont.—The Chartered Trust Co. applied to the Board of Control for a sewerage system for the new subdivision in the Leslie Nurseries property on Queen St. East, at a cost of \$84,000. The Board recommended that the system be installed.

Weston, Ont.—Plans for repairing and extending the water system were presented to the Town Council by members of the Water, Power and Light Commission. The commission proposes to line the reservoirs with concrete, and generally bring the system up to date. The cost is estimated at \$17,000.

Windsor, Ont.—The Essex Border Utilities will make another attempt to meet the Windsor Water Board and the Walkerville Water Co. The plan, it was explained at a meeting of the Commission, will not interfere with the distribution plants at Windsor and Walkerville. Each of the interested municipalities will have sole control of distribution, with the Commission in charge of delivery from the filtration station.

Winnipeg, Man.—The City Council intends to construct a sewer in Beach Ave., from the C.P.R. to Kent St., at a cost of \$1,627. City Clerk, C. J. Brown.

York Twp., Ont.—The contract for the construction of 6-in. watermains on Alleen Ave., Connor Ave., Doncaster Ave. and Rosevear Ave. has been let to Gordon Thompson, 57 Howard Park Ave., Toronto.

LIGHT, HEAT AND POWER

Brantford, Ont.—C. E. Kirkby, superintendent of the Brantford township Hydro system, announced that work on the Tutela Heights Hydro line will start immediately.

Courtright, Ont.—On February 6 a by-law will be voted

on by the ratepayers to authorize the borrowing of \$11,500 for the purchase and installation of Hydro-electric equipment. Clerk, R. G. Stewart.

Sturgeon Falls, Ont.—The Northern Ontario Light and Power Co. is considering the purchase of the power rights held by the McIntyre-Porcupine Mines on the Sturgeon Falls, Mattagami River. If the deal goes through and McIntyre assigns its power license at Sturgeon Falls to the power company, there will be available for development and for supply to the Porcupine mining district, an additional 7,000 h.p.

Toronto, Ont.—City Architect Price submitted three separate propositions to the Board of Control for the heating of the Live Stock Arena at the Exhibition Grounds. Two of them were elaborate, involving expenditures of from \$100,000 to \$130,000. The other, and probably the one that will be adopted, provides for an addition to the present temporary heating plant at a cost of \$7,000. Action was deferred.

Winnipeg, Man.—The contract for the supply of 2,000 ft. of 13,000-volt and 2,000 ft. of 2,300-volt cambric insulated fireproof braided cable, has been let to the Canadian General Electric Co., Ltd., at \$3,795, f.o.b. Winnipeg.

RAILWAYS

Birch Cliff, Ont.—The Toronto and Eastern radial by-law was given its third reading by the Scarboro Township Council. Scarboro's share of the bonds for its construction will be given to the Hydro-Electric Power Commission of Ontario with authority to proceed with the construction of the road, either with or without the consent of the Government.

Brantford, Ont.—The City Council approved the \$80,000 by-law for the extension of the street railway.

Guelph, Ont.—The Grand Trunk Railway Co. plans track alterations in this city.

Kitchener, Ont.—At a public meeting held in the City Hall a committee headed by Geo Lippert, was appointed to work in conjunction with the Railway Committee of the City Council to consider protection of all railway crossings, including a subway at King St.

London, Ont.—The London & Port Stanley Railway Commission has empowered Sir Adam Beck, the chairman, to enter into negotiations with the Grand Trunk Railway for the taking over by the L. & P. S. R. of a building owned by the Grand Trunk Railway, at the northeast corner of Richmond and Bathurst Streets for the purpose of converting it into a depot for the city's railway, at a cost of \$20,000.

Uxbridge, Ont.—Henry Strang, of Hensall, Ont., Township Clerk, has been instructed by the Township Council to ascertain from the Hydro-Electric Power Commission of Ontario the steps necessary to insure a hydro radial from St. Mary's via Kirkton and Exeter to link up with the proposed electrified Huron and Bruce Railway, ultimately extending to Grand Bend via Dashwood.

Toronto, Ont.—The City Council gave third reading to the Toronto Suburban Railway purchase by-law.

FACTORIES AND LARGE BUILDINGS

Bridgeburg, Ont.—At a recent public meeting of School Section No. 6 of the adjacent township of Bertie, it was decided to co-operate with School Sections Nos. 2, 4 and 10 in order to secure for the township immediately surrounding Bridgeburg and Fort Erie a consolidated school.

Chatham, Ont.—The Separate School Board have decided to proceed at once with the construction of a new separate school in North Chatham. Some time ago the Halliday property on Victoria Avenue was purchased for \$12,000.

Copper Cliff, Ont.—The public school which was valued at \$100,000 was recently destroyed by fire. The school will be rebuilt at once. Secretary of School Board, Mr. Gallagher.

Crediton, Ont.—The members of the Methodist Church have decided to rebuild at once the church recently destroyed by fire. Plans will be prepared by Architect J. Vicar Munro, of London.

Clover Bar, Alta.—A movement is on foot here for the erection of a church. Address R. P. Ottewell.

East Toronto, Ont.—The Y.M.C.A. plan the erection of a new building on Gerrard St. next summer.

East Toronto, Ont.—The Grand Trunk Railway plan the erection of a Railway Y.M.C.A. building on a site near Kimberley Ave. The work will be commenced in the spring; also the erection of a new freight shed and railway passenger station.

Glanworth, Ont.—Plans for a library building have been prepared by William Murray, Architect, London, Ont.

Kitchener, Ont.—Fire damaged the Weber Chambers to the extent of \$15,000.

Kingston, Ont.—The Provincial Department of Agriculture is being urged to rebuild at once the Eastern Ontario Dairy School, recently destroyed by fire.

London, Ont.—Hyatt Bros. have the contract for rebuilding the cigar factory of William Ward & Sons, Ltd., which was recently damaged by fire to the extent of \$40,000.

London, Ont.—This city plans to spend about four million dollars on schools this year, according to the extensive program of building outlined by the Board of Education. An addition to the London Technical and Arts Schools is estimated at \$1,000,000, while the program provides for erection of new buildings to cost \$400,000, including a new 14-roomed school in West London, and the first unit of a 17-roomed school in East London.

Lunenburg, N.S.—Fire destroyed the storehouse of Adams & Knickie.

Melbourne, Ont.—The Public and Continuation School was destroyed by fire.

Mitchell, Ont.—A one-storey addition is to be erected in the rear of the main factory of the Wettlaufer foundry.

Montreal, Que.—The Vimy and Harvard Apartments, 5618-26 Sherbrooke St., valued at \$250,000, were destroyed by fire.

Montreal, Que.—The construction of an ice arena on the corner of St. Luke and Atwater Streets will commence early in April. Estimated cost, \$400,000.

Newmarket, Ont.—The Agricultural Society plans the erection of a new poultry building. President, W. H. Eves.

Ottawa, Ont.—A movement is on foot for the erection of a Community Hall.

Ottawa, Ont.—The Butterworth Building, 197 Sparks St., was damaged by fire to the extent of \$12,800.

Paris, Ont.—A three-storey building will shortly be erected on Grand River St. by Daniel McTavish.

Port Arthur, Ont.—Work on the erection of their new paper mills will be commenced here shortly by the Provincial paper Mills, Ltd. The building will be 900 ft. long and will cost with the equipment about \$1,000,000.

Port Credit, Ont.—The School Board authorized the preparation of plans for an addition to the Forest Avenue School. Chairman, Mr. Maybee.

Quebec, Que.—The sub-committee of the Catholic School Commission decided to ask for plans for the reconstruction of the Sacred Heart School on Grant St., which was destroyed by fire. Estimated cost, \$40,000.

Regina, Sask.—Plans for the construction of a public comfort station have been prepared by Storey and Van Egmond, architects. Estimated cost, \$25,000. Tenders will probably be called for about March 1.

Sarnia, Ont.—West Lambton Fair Board will consider the erection of a poultry and horticultural building. President, C. A. McArthur.

Silverthorne, Ont.—The trustees of S. S. No. 35 will ask the ratepayers to ratify the proposition to raise \$161,000 for a new school, together with the site. The cost of the school when completed would be about \$200,000.

Thorold, Ont.—A committee of the Board of Trade has been formed to negotiate with the Government for a new post office.

Toronto, Ont.—A. Stolberg plans to erect a factory on the north-east corner of Keating St. and Carlaw Ave.

Toronto, Ont.—The members of Hillcrest Church of Christ plan the erection of a new church at a cost of \$50,000.

Toronto, Ont.—The Chartered Trust Co. proposes to start work at once on 50 of 200 houses which they propose to build on Queen St. East.

Toronto, Ont.—The members of Oakwood Presbyterian Church are considering the erection of a new church. Pastor, Rev. Dr. T. Wardlaw-Taylor.

Toronto, Ont.—Mount Pleasant Ratepayers' Association decided to ask the city to provide funds for the building of a branch library in North Toronto.

Toronto, Ont.—Plans for the new Jarvis St. Collegiate of 32 rooms were adopted by the school property committee. The building is estimated to cost \$450,000.

Toronto, Ont.—At the annual meeting of Bloor Street Baptist Church a committee of members was appointed to inaugurate a campaign for the erection of a new church.

Toronto, Ont.—The members of the Church of the Resurrection (Anglican) plan the erection of a new church at Milverton Blvd. and Woodbine Ave., at a cost of \$32,000.

Toronto, Ont.—A recommendation was forwarded by the Board of Control to the City Council favoring the passing of a by-law authorizing the issue of debentures for \$2,500,000 to enable the Board of Education to proceed with its building program.

Toronto, Ont.—The erection of buildings in a number of parks, including a new bathing station at Hanlan's Point, have been recommended by the Parks Department, and amounts to cover the cost of these will be included in the estimates of the current year.

Victoria, B.C.—Tenders addressed to the City Clerk, for the purchase of an existing railway swing span bridge, will be received until noon, March 6. (See official adv.).

Wellington, Ont.—The contract for the construction of a Consolidated School has been awarded to the Norman MacLeod Co., Ltd., Kent Bldg., Toronto.

Windsor, Ont.—Ald. Samuel Keyser plans to build a large apartment house at a cost of \$150,000.

Winnipeg, Man.—The Woolworth Building was destroyed by fire.

Winnipeg, Man.—Fire damaged the Woods Building to the extent of between \$25,000 and \$40,000.

Yak, B.C.—The Provincial Department of Public Works awarded the contract for the construction of a school here to J. MacLeod, of Cranbrook, B.C.

MISCELLANEOUS

Bienfait, Sask.—A provincial charter has been granted to the Lignite Coal Mines, Ltd. Capitalization, \$200,000.

Chanvin, Alta.—A provincial charter has been granted to the Kirby Construction Co., Ltd. Capitalization, \$20,000.

Edmonton, Alta.—A provincial charter has been granted to the Barry Sheet Metal Co., Ltd., Edmonton. Capitalization, \$20,000.

Georgetown, Ont.—The offices of the Georgetown Foundry Co. were damaged by fire to the extent of \$10,000.

Kingston, Ont.—The City Council decided to call for tenders for annual supplies. Clerk, W. W. Sands, M.D.

Lethbridge, Alta.—Tenders addressed to the Irrigation Council of Alberta, Lethbridge, Alta., will be received until 3 p.m., February 21, for Branch Canal Masonry (See official adv.).

London, Ont.—The approval of the Board of Health has been received by the Public Utilities Commission for the expenditure of \$250,000 on waterworks and electrical development in this city. The Council will now be asked to take the necessary steps to have the question placed before the Ontario Railway Board for sanction. A by-law will be prepared with this end in view at the next meeting of the Council.

Mimico, Ont.—The Town Council decided upon the following expenditures for local improvements: Sewers and

waterworks, \$30,000; roads, \$45,000; and sidewalks, \$5,000. Town Clerk, J. A. Telfer.

Ottawa, Ont.—Works Commissioner A. F. Macallum will make a report to the Board of Control on the proposed improvements to the shore of the Rideau river, east of Bank St.

Ottawa, Ont.—Application will be made to the Legislative Assembly by the Municipal Corporation of the City of Ottawa for authority to execute and complete the following works and to raise upon debentures the sums of money mentioned for same: The construction of a sewer to serve the Lady Grey Hospital at a cost of \$85,000; completion of the Pinard St. sewer, \$18,000; construction of an asphalt or asphalt and wood-block pavement on Nicholas St., between Rideau St. and Laurier Ave.; completion of the St. Patrick St. bridge, \$85,000; permanent repairs and additions to the Civic Garage, \$10,000; construction of a viaduct over the Grand Trunk and Canadian Pacific Railway tracks on Wellington St., \$150,000 (Corporation's share); construction of a bridge over the Rideau Canal at Somerset St., \$100,000 (Corporation's share); construction of water main extensions and services, \$100,000; and the purchase and installation of water meters, \$30,000.

St. Catharines, Ont.—The local Chamber of Commerce has been assured by Hon. W. C. Kennedy, Minister of Railways and Canals, that engineers of the Department have been instructed to report on the feasibility of constructing a turning basin and docking facilities on the Welland canal here.

Sapperton, B.C.—Fire caused a half million dollars' damage to the Brunette saw mills. The saw and planing mills are destroyed.

Toronto, Ont.—Works Commissioner R. C. Harris will report to the Works Committee on the paving of St. Clair Ave., from Cobalt St. to Runnymede Road.

Toronto, Ont.—The Works Committee adopted a supplementary report from Works Commissioner for authority to proceed with the construction of a new bridge on Gerrard St. over the Don, at a cost of \$832,000.

Toronto, Ont.—The Works Committee passed the estimate of Works Commissioner Harris for the construction this year of a pure water reservoir at the Island at a cost of \$750,000. Estimates amounting to \$894,486 for water main extensions were also passed by the Committee.

Toronto, Ont.—The Works Committee passed the estimate of Works Commissioner Harris for the construction this year of a bridge on St. Clair Ave. east, over Reservoir Ravine, at a cost of \$712,000. The proposed new bridges across the ravine at North and South Glen Road and the Spadina road bridge were struck out of the estimates by the Committee.

Toronto, Ont.—Estimates of the Works Department for 1922, prepared by Works Commissioner R. C. Harris, call for a total expenditure of \$10,425,101. Under the heading "Capital Expenditures," for which \$7,765,970 is asked, \$2,021,904 is for sewers, the largest item of which is \$552,000 for a relief sewer down Rosedale ravine, from Yonge St. to the Don. There is another item of \$210,000 for a relief sewer from Bloor St. via Charles, Church and Park Road, to Rosedale relief sewer; Parkdale district relief sewer, \$461,000; Roncesvalles district relief sewer, \$150,000; Jones Ave. and Gerrard St. relief sewer, \$136,000. In the railway and bridge section the north and south Glen Road bridges are reinserted at an estimated cost of \$1,050,000; replacement of Spadina Road Bridge, \$72,000; Moore Park bridge, \$712,000. In the water supply section \$1,050,000 calls for the following: Additional pumping station and steam plant at Riverdale, \$200,000; 20,000,000-gallon reservoir at the Island, \$750,000; additional high pressure pump, \$100,000. For water mains the amount requested is \$2,813,566, of which \$723,080 is for a 36-in. main from Front St. to Dupont St.; \$448,694 for mains from the main pumping station to Front St., \$975,000 for extension to the high pressure system, which was recommended by the commissioner last year; \$221,000 for an improved supply at the Island.

Walkerton, Ont.—The Town Council has started the

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

New Road Bridge Opened Over Sixteen Mile Creek

Provides Alternate Route From Toronto to Hamilton — Longest Bridge Yet Constructed on Provincial Highways — Eliminates Last of Heavy Grades on Dundas Road — Details of Design and Erection Methods Described

BY T. D. MYLREA

Engineer, Norman McLeod, Ltd., Toronto

WITH the formal opening on December 20, 1921, of the new bridge over Sixteen Mile Creek, on the Dundas Road, five miles northwest of Oakville, Ont., the second and last heavy grade on this Toronto to Hamilton route was removed. It has long been recognized that owing to the heavy traffic on the Toronto-Hamilton Highway another thoroughfare was desirable, and the old road opened by General Simcoe offered a direct route equally as short as

to make a straight line passage by the cut and fill method, beginning operations on the west bank. Excavating by means of shovels and wheelbarrows they succeeded in making a cut about thirty feet deep, but the excavated material was washed away as soon as thrown over the bank, so that the efforts of these courageous men led to nothing.

Consequently, the only remaining means of getting across the valley was taken. A ramp-like slope was cut



BRIDGE OVER SIXTEEN-MILE CREEK, NEAR OAKVILLE, ONT.

the Highway. It had the additional advantage of affording a much more direct route, over the Hamilton-Guelph road, to Guelph, Kitchener and other large towns lying between these points. While a section of the road is still unpaved, the Provincial Highways Department is actively at work, and it is anticipated that before long this work will be complete.

Old Time Method of Crossing Ravine

The Sixteen Mile Creek ravine has long been a bugbear to traffic. Years ago a group of nearby residents attempted

down each bank with sharp turns at top and bottom, and the creek was bridged with an 85-ft. steel truss span having a 16-ft. road way. The soil being of shaley clay, these 16½% grades were very dangerous, particularly in wet weather. A glimpse of one of the grades may be seen over the old truss span, between the two right hand piers on the photograph.

Principal Dimensions of Bridge

The bridging of the Twelve Mile Creek near Tansley on the same road was recently carried out so successfully that the same design and method of construction was adopt-



SECOND SPAN READY TO BE LOWERED—PILOT STILL IN PLACE



FIFTH SPAN READY FOR THE PILOT TRUSSES



REFUGE BAYS ARE PROVIDED OVER EACH PIER

ed in bridging the Sixteen Mile Creek, and with equal success, although the Sixteen Mile Creek Bridge is a much bigger structure. The super-structure of the new bridge consists of a concrete floor carried upon eight spans of lattice trusses of 108 ft. 6 in. span, spaced 13 ft. 6 in. center to center, with 65 ft. span at the west end. These girders were formerly in use on the Intercolonial Railway, and had been replaced because of the heavier traffic. With new cross frames and laterals, analysis showed them to be entirely inadequate for their new usage. The spacing of the piers was therefore predetermined. The 65 ft. span, which is at the right hand end of the photograph cannot be seen owing to the fact that it extends up the gully excavated so long ago.

The distance from face to face of the ballast walls is 934 ft. which with the 30 ft. splayed wing walls of the abutments gives an extreme length of 993 ft. The height from water level to bridge floor is 117 ft. The clear distance between handrails is 20 ft., and allowing for a 6 in. curb on each side, a 19 ft. roadway is provided. There are no sidewalks, but over each pier on both sides of the bridge are refuge bays 12 ft. 9 in. long and 3 ft. wide, with floors flush with the top of the curbs. The roadway is crowned 3 in. at 20 ft. centers on each side are drain holes. A projecting lip on the bottom edge of each hole prevents water from trickling over the structural steel.

Altogether there were 370 tons of structural steel, 145 tons of reinforcing steel and 8,300 cu. yds. of concrete in the structure.

The County of Halton, which carried into execution the construction of the Tansley Bridge, also undertook the work of building the Sixteen Mile Creek Bridge. The Dundas road, however, was at this time taken over by the Provincial Department of Highways, and the work carried to completion under its direction. The new bridge, as well as the Tansley Bridge, will safely carry the heaviest class of loading prescribed by the Department of Highways.

In the design of the bridge simplicity and economy were kept foremost in mind, as far as possible consistent with appearance, no elaborate ornament being used anywhere in the structure. The upper 50 ft. of all piers is identical and consists of a pair of twin columns braced with struts 3 ft. x 4 ft. 6 in. reinforced to resist wind stresses. These columns are each 6 ft. x 12 ft. at the bottom and are battered toward the top. The only difference in the various piers is in the height of the lower portion, except that the three piers closest to the creek are provided with ice breakers to resist the rush of ice in the spring break-up. The lower shafts were made hollow, resulting in a saving of more than 1,000 yards of concrete.

Before deciding on the type of floor construction various designs were made. The comparative cost of steel and concrete floor beams was found, with the result that concrete floor beams at 5 ft. centres, coming over the panel points, were used. The additional cost of sidewalks and of refuge bays was computed and owing to the fact that the distance from any town precluded any large pedestrian traffic, sidewalks were abandoned, but the refuge bays mentioned above were provided.

The handrail is formed of precast panels set in grooves in the curb. These panels were made as nearly alike as possible, slight variations resulting in the refuge bays and larger posts. They were cast on the flat, the openings being formed by strips of wood of proper shape tacked to the forms. By making all openings the same size and taking up variations in panel length by slightly varying the width of the spindles, the same moulds were used for all panels. The upper rail and intermediate posts were poured after setting the panels in place.

One end of each girder is fixed and the other end rests upon a nest of rollers. However, to provide against the possibility of the movement of the rollers being hindered by accumulated dirt, each pier is designed to resist the bending set up by temperature changes in the trusses. The resultant stresses and soil pressures in all cases are quite low. In the design of the fixed shoes and also in the sole plates under the roller rests, the deflection of the trusses under the heavy dead load was considered. As may be seen in the detail, a strip of metal 4 in. long and the full width of the shoe projects downward from its lower surface. These strips bore directly on the piers, and after the full dead load was in place and full deflection had occurred, the remaining space under the shoes was filled with a strong mortar. Thus all danger of the shoe riding on its forward edge with the consequent possibility of spalling off the pier copings was obviated.

Expansion joints are provided in the bridge deck, in the floors of the refuge bays and in the handrail directly over each pier. In the floors and decks plates fastened to one slab are free to slide upon the adjoining one. In the handrail, pins fixed to the end of one rail slide loosely in pipes embedded in the end of the next one.

Cable-way Used in Construction of Bridge

The construction of the bridge was carried out entirely by means of a cable way composed of a 2-in. steel cable, supported by 100 ft. wooden towers 1,200 ft. apart, and



CLOSE UP VIEW OF HAND RAIL AND REFUGE BAY

was capable of lifting a load of 5 tons. Owing to the fact that this cable way could be used for only one operation at a time a large number of men was not required. The trusses were brought from Oakville to the east bank of the valley, where they were assembled and launched; and all operations were therefore started at the east end and carried on toward the west. All other material was brought to the west bank since the quarries, mills, etc., were closest to this side. The construction plant, consisting of a derrick, with a clam shell bucket for rehandling the materials, measuring hoppers, concrete mixer and cable way driving mechanism, was also located on the west bank. Advantage was taken of the small gulley, previously mentioned, in the location of the mixing plant. The measuring bins were on the ground level, on the edge of the gulley and the concrete mixer was located part way down its side. Thus in handling the materials from the stock piles to the measuring bins no great lift was required, and the materials were chuted from the bins to the mixer by gravity. A small pumping station, located on the edge of the creek, supplied water for the various purposes required.

As all foundations were in a soil composed of shale and practically impervious clay, no water troubles were encountered even in those piers nearest to the creek.

One set of forms sufficed for all the piers. As may be seen in the photograph they were built up in independent sections and 14 ft. high, and as the concreting progressed upwards in one pier the forms from the lower portions were removed and used in the next one. The reinforcing rods were ordered in lengths just enough longer than the height of the corresponding form section to provide a proper bond to the next section above. Thus in pouring the concrete there was no trouble in getting the cable way bucket close to the spot where the concrete was to be dumped. A forest of rods projecting a long distance upward would have made this an exceedingly difficult matter. Each form section was assembled on the ground, and all the reinforcing rods in that section were securely wired in position, and form section and bars were hoisted into place as a unit. This did away with the difficulty of building forms and placing steel high in the air. In the removal of the side panels of the upper section of these pier forms, the cable way was at a slight disadvantage. The panelling in the outer face of the twin columns made it impossible to remove the forms by direct lift, and it was necessary to resort to a tag line carried up the valley to give the required lateral movement.

Unique Method of Erecting Trusses

Owing to the height of the piers, the cost of falsework for the erection of the trusses would have been prohibitive, and a unique method of launching was devised by the contractor. Each pair of trusses, with the lateral bracing riveted in place, was pulled forward on greased rail until it projected nearly half its length over the truss previously placed. The back end was temporarily lashed down and a pair of triangular pilot trusses, 60 ft. long, extended just over the next pier. The projecting ends rested on rollers carried on blocking on top of the pier. Girders and pilot

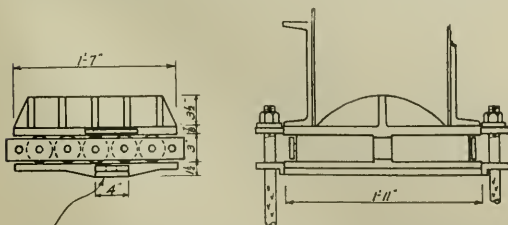


VIEW FROM BELOW SHOW RELATIVE HEIGHT OF OLD AND NEW STRUCTURES

trusses were both moved forward by a block and tackle arrangement operated by the cable way. The pilot trusses were removed, and the girders lowered into their proper position by jacks. Before launching, the tension web members of each truss were all temporarily reinforced to insure their proper action while the trusses were in a cantilevered position. As soon as the last girder had passed over the first span the work of concreting began and followed close behind the advancing trusses to completion.

The Sixteen Mile Creek Bridge was designed and constructed by Norman McLeod, Ltd., Engineers and Contractors, of Toronto, under the direction of the Provincial Department of Highways, and under the immediate supervision of Jas. A. Bell, consulting engineer, St. Thomas.

An important order has been awarded to Vickers' Ltd., London, England, for material for the electrification of South African railways. The total value of the contract is between £750,000 and £1,000,000, and was secured in the face of keen, foreign competition.



Masonry plate under rollers to bear only on 4" face until span receives its full dead load, thus permitting the shoe to adjust itself to the deflection of the span. Masonry plate then to be wedged up at the free ends and grouted under for full bearing.

DETAIL OF SHOE.

At a meeting of the Executive Committee of the Montreal City Council, it was suggested that a drainage board be formed along the lines of the present water-board. It was believed that such a board or commission would insure better co-ordination in plans of sewers now being built or contemplated. In the course of the discussion, instances were cited where the insufficiency of sewers was the cause of frequent floodings by the fact that the sewers were too small for the localities, or where a large sewer emptied into a small one, or where a large trunk sewer had been built at the cost of \$800,000 and had never been utilized.

PREPARING BITUMINOUS GRAVEL AND SAND ROADS

Practice for Repairing Roads Followed in Massachusetts —
 Author Discusses Bituminous Treatments and Gives
 Interesting Figures on Road Traffic.

By W. D. Sohler

Formerly Chairman, Massachusetts Highway Commission.

IT is prerequisite to having any road at all, even the dirt road, (1) that the road shall be adequately drained with not only side ditches but all necessary culverts to carry the water away from the road and the sub-base; (2) that for any poor soil such as silt, clay, loam, or other fibrous or soft material, an adequate foundation be provided. Frequently 12 in. of gravel or good sand will prove to be fully as good a foundation as 8 in. of field stone or Telford.

Under the topic bituminous treatments, surface treatments as well as bituminous construction will be discussed. To have any success at all, the road surface to be treated or coated must be absolutely well compacted, firm, and true to crown and grade with no dust pockets or soft material. The macadam should be brushed clean and the gravel road well shaped and free from surplus loose dust.

A bituminous top on a road is waterproof and it must not be put on any road that is rough or rutted, because if it is, it will hold water in the depression, and every passing automobile or truck will throw the water out and take pieces of the road with it, so that in a short time you have very large holes all over your road.

Bituminous Surface Treatments

We find in Massachusetts, where we have very much more motor traffic than you are likely to have here, and whenever a road has an average of more than 150 motor cars a day, that it is impossible to maintain, either a gravel road or a waterbound macadam, without some bituminous surface on the top. This can be either of tar or asphaltic oil, never use any oils that have a paraffine base. Paraffine is a lubricant, and you want to use something that has a gum stickum and sticks your road together.

You can always tell whether the material you are going to use will produce good results or not, by putting some on your finger and thumb and rubbing them together. If they stick together and you cannot rub it off the finger without the use of pumice stone or your penknife they will stick to the road. If it will wipe off with a newspaper and merely leave your finger greasy and dirty like the grease from your automobile, then it will be no good on the road.

In preparing to apply a bituminous surface treatment always get out your covering and spread it on the road side before you start to apply the bitumen. It requires about 10 pounds of gravel or sand covering for every square yard of road surface, when you are using the lighter cold tars or oils and the heavier grades will require from 15 to 20 pounds to the square yard. If possible always spray on your bituminous material with a pressure distributing machine.

Apply about a sixth of a gallon to the square yard, and apply it to only one half of the width of the road at a time, have your men who are to spread the covering follow right along and spread it quickly and as evenly as possible.

Have them go back and be sure that the whole road is covered and kept covered so that it does not bleed, at any rate for the first week. It costs money to buy bitumen and whenever it is carried off the road it leaves a bare spot that will ultimately cause a hole in a very short time in wet weather, and thereby ruin your road.

The only remedy is to patch the hole at once, by painting it with the same material used with a whisk broom, and then be sure you cover this patch with sufficient material to prevent it picking up the second time.

Bituminous Materials, Tars

Now in regard to the material, we have got most excellent results with cold tar and material like Tarvia. It on both well shaped gravel and macadam roads, but be sure the surface is very firm or hard. The tars set up almost

immediately are brittle, do not heal themselves and while they make a most excellent road surface, they should not be used upon any loose or uncompacted road surface. They tend to break and go into pot holes and if these are not immediately patched your road very soon disintegrates and goes to pieces.

The proper way is to renew the surface film, immediately the underneath part of the road surface is uncovered, otherwise, a spot starts the size of a dollar which will soon become larger if there is considerable traffic.

Asphaltic Oils

The asphaltic oils, on the other hand, can be applied to softer and looser road surfaces, particularly gravel. You can use the asphaltic oils that can be applied cold containing about 45 to 50 per cent of asphalt.

Apply about a third of a gallon to the square yard of road surface and cover it, in the manner described above. This treatment can be repeated, and when asphalt is used you will find that you can shape your road back in the Spring and apply your second surface treatment, and you will have a considerable quantity of the asphalt left, so that the results during the second year are much better and more permanent than they were the first. After two or three applications, unless your traffic is extremely heavy, you will find that you have a road surface that may go for a year or two years, without another treatment, always provided you keep it properly patched.

Suggestions for Patching Roads

Always patch before you get a hole and keep the surface intact. When patching, make the sides of your hole with a little shoulder, to hold the material in place, use some patching material either the asphaltic oil used on the road, or K. P. which is a material made of tar that can be used cold, or something like Headly oil which is a fluxed asphalt that can be used cold. Grade your material, using either gravel bank or broken stone with sizes that are at least a half the depth of the hole for the larger sizes and graded down to the very finest sand, say a sand that will pass a 200 mesh. Be sure it is thoroughly mixed and coated before it is put into the hole. Tamp it in and remember that it expands a little with water so leave your hole possibly one quarter of an inch below the surrounding surface of the road or you will find a bump will develop later.

After the patch is made, cover it before you leave it with dry sand, or if necessary, dirt from the road side to keep it from being picked up by passing vehicles. You want to keep your bituminous surfaces on the road and to do this, they must stick to the road firmly.

Bituminous Gravel

We have had most excellent results in Massachusetts in building what might be called gravel asphalt roads. We have built them since 1912 and they are all in excellent condition to-day. As we have gone along, we have constantly built them better and stronger because of the increase in heavy motor truck traffic.

Originally, we merely made a sub-base carefully compacted to a true crown and grade, mixed the gravel and asphalt in a pit, hauled it to the road, spread it evenly over the surface 18 to 21 ft. in width, about 3 in. in depth loose so that when it was rolled it compacted to two inches.

All our later roads have had about 4 in. of broken stone of very coarse gravel underneath in the sub-base and very carefully shaped rolled and compacted and the asphaltic gravel has been spread upon that.

The mixture must be very evenly spread, so that it will compact smoothly and without any rolls or bumps. To do this, it is absolutely necessary that it should be dumped on a dumping board preferably of sheet iron and shoveled from this board as evenly as possible on to the road and then very carefully spread upon the road with rakes, so as to secure uniform spreading and density. I will give at the end of this paper the specification, so that I need not go too much into details just now.

As soon as possible, the mixture should be rolled with a light roller, a tandem roller is best, but a horse roller can be used if necessary. Roll it not only length ways but cross ways and diagonally, so as to avoid any wavy surface.

Never let the roller stand on any of the soft material or even stop on it, because it will make a depression, until it is thoroughly cool and compacted, run the roller onto the hard surface beyond to a stop. It is hard to give a rule for the proper time to roll; the mixture must be cool enough but not too cool.

In building these roads, the gravel has to be heated and uniformly heated to 250 to 300 degrees Fah. and the asphalt must be heated in kettles to 300 to 500 degrees. The two should then be mixed in some mechanical mixer, preferably a hot mixer, from this it is dumped into the cart and carried to the road and spread.

It is ready to roll, and should be rolled while it is still soft enough to compact thoroughly; this means the temperature of the mixture should be from 90 to 120 degrees Fah. This part of the work is occasionally troublesome, particularly when the mornings and evenings are cool, because the bottom on the ground and on the top exposed to the air will cool more rapidly than the middle. You cannot roll while the middle is too soft or too hot, because it will then squeeze out ahead of the roller and make waves, so you must wait until you can roll it without having it push out much ahead of the roller.

We have built a good many miles of road in Massachusetts of bituminous gravel and we think very highly of them, even for a very great volume of traffic, including quite a number of heavy trucks. We have also resurfaced and widened a great many miles of road, by this I mean 75 to 100 miles, where we used the old waterbound macadam road as a foundation, when there were 2 or 3 in. of it still left.

Where the traffic was heavy and we were building a bituminous gravel road, we have of course put in a foundation of gravel or field stone where the sub-soil was not good. We have then usually put a crusher into the gravel pit and crushed the larger stone, and perhaps field stone as well, and have laid the foundation of broken stone about 4 in. thick, well shaped and thoroughly rolled. On this, we have spread the mixed gravel and oil, so that it would be about 2½ in. thick, after rolling with a steam roller. Even with good soil conditions, where the roads had heavy traffic, we have used either broken stone or gravel in the sub-base, so that when watered and thoroughly rolled by the steam roller, it would be 4 or 5 in. in thickness.

The top course or wearing surface is just a mixture of asphaltic oil of from 90 to 120 penetration, thoroughly mixed with the heated gravel, and spread evenly so that it would be about 2½ in. thick after rolling. A tandem roller seems to be the best for rolling this material, as it can be used while it is hotter without producing depressions. This mixture usually requires about from 20 to 22 gallons of oil to the cubic yard of loose gravel, the oil being measured hot. The best results are obtained by the use of a gravel, using no size above 1½ in., but containing the other sizes down to the very finest material. It is advisable sometimes, if you have not enough fine sand in the gravel, to use stone dust or secure some fine sand from elsewhere, as the fewer the voids and the denser the mixture, the better the results. You do not need to infringe the Warren patent specifications. Here again, the finer the material, the greater the quantity of asphaltic oil that must be used per cubic yard and the stiffer the asphalt that should be used. Roads built of these surfaces have withstood very heavy traffic where the foundations are good from 8 to 9 years already, and are still in good condition.

Minimum Width of Road

These roads should be built at least 18 ft. in width, even with good material in the shoulders; with poor material, they should be 19 or 20 ft. in width to prevent having the sides cut off. A ¼ in. crown to the foot is better than a ½ in. crown. We now have a practice of banking all the corners and curves where it is physically possible

and giving them a grade from the outside to the inside of ½ to ¾ in. to the foot of width. When we first began the work, we used California asphaltic oil with good results, and since then we have used Texas, Mexican and other asphaltic oils with very good results.

Originally, these roads cost no more, and usually a little less, than waterbound macadam, and they were much more economical to maintain and withstood automobile traffic and motor traffic much better.

They originally cost about 60 cents per square yard, including the broken stone or gravel bottom, but not including grading, foundation or drainage. Last year the cost for the surface ran up to \$1.25 to \$1.50 per square yard, materials, teams and labor having advanced in price.

Traffic Roads Will Withstand

It is hard to predict just what traffic, sand and oil roads will withstand. They have now stood for 12 years in reasonably good condition on roads that had 600 to 800 automobiles a day, 47 to 70 2-horse teams a day, and an average of about 38 trucks a day. They have had go over them without any noticeable damage quite a few motor trucks carrying oil or gasoline that would weigh up to 14 tons including truck and load.

The gravel and oil mixed roads, and those that have been resurfaced with gravel and oil, have stood satisfactorily for 6 to 8 years with much heavier traffic than this, especially in trucks. I have in mind one section in particular that was constructed and opened up to traffic leading directly to Camp Devens, where, as you perhaps know, they had a cantonment for about 30,000 soldiers, built during the war. It had some days as many as 700 trucks going to that cantonment, and when they built a very large hospital there, they moved from 30 to 40 lumber trucks, weighing 12 to 13 tons including the load, over that road every day. This made very heavy traffic indeed for the two years that the road has been built. I think I am safe in saying that this road has never shown any signs of weakness or needed any patching whatever.

A blanket coat of hot oil on macadam will carry a much larger number of teams if there is a ratio of two to three automobiles on pneumatic tires to each team to keep the bituminous surface constantly rolled down when the horses and teams pick it up. But note that a very few teams on narrow tires, or a few very heavy teams every day, will destroy the surface if the load is heavy to shear down entirely through the surface to the stone.

If this process is repeated once or twice a day, a rut soon develops and the road becomes muddy and the bituminous surface is rapidly disintegrated. Light oil or cold tar will then be more serviceable, laying dust while the stone takes the wear.

We have maintained a few miles of road in reasonably satisfactory condition with annual applications of a cold tar or water gas tar. They have required one-half gallon per square yard annually, and the results have been about the same and certainly no better than where we have applied two quarter gallon coats per square yard of light asphaltic oil the first year and one quarter gallon per square yard each succeeding year. The cost for the cold tar has been more.

Invariably we clean and patch the road first and cover the bituminous material sufficiently to prevent its picking up. We have sometimes tried dispensing with the cleaning and covering but shall not repeat that expensive experiment. We can usually have the light asphaltic oil sprayed onto the roads by motor trucks for 1.2 to 1.5 cents per sq. yard, using one-fifth to one-quarter gallon per square yard.

The cleaning, patching and covering costs about the same. You must use some bitumen on the surface of either a gravel or a waterbound macadam road, if there are any motor vehicles using the road every day, say over 100.

Economical Road Surfaces

It can be stated in several ways: When your road costs you more than 10 to 15 cents per square yard a year, to maintain it always in proper condition, it is cheaper to substitute some more expensive and more permanent road

surface or road, and pay the yearly interest and sinking fund requirements to extinguish the cost of the road in a series of not more than from 15 to 20 years. No road should be bonded for any longer period.

Another way of stating it, would be that taking a waterbound macadam road or even a gravel road that whenever it wore out, more than half an inch per year under the traffic and certainly beyond any question, when it wore out an inch a year, because of the traffic, you are absolutely driven to a stronger and more expensive type of pavement. This, not only because of the cost of the yearly maintenance which is far in excess of the cost of interest and sinking fund, but also because when any road wears out more than half an inch a year, it never does so evenly, and no matter how much money you spend, you can never keep that road surface in any proper or satisfactory condition.

If the average, is say, one inch, that means that the road wears, say an average from a quarter to half an inch in some places but three or four inches in others, and is therefore, full of large holes and depressions.

It really is not then a question of resurfacing proper but the only way to get the road back into condition is to spike it up, reshape it, add new material to it, an average of an inch the whole length of the road and reroll it. This really comes very close to reconstruction, and when this time arrives, it seems to me, it is not a question of argument, but of demonstrated fact, that a stronger road crust should be provided at this time, with at least as good as a bituminous gravel, or bituminous macadam built by either the mixed or penetration method, at any rate, for the top two inches, using a proper grade of either asphalt or tar. The yearly maintenance would immediately be reduced to practically nothing on the road surface of a properly built road for the first two or three years and should not exceed a very few dollars per mile for patching the few holes that might develop during the next ten or twelve years.

I may say, that in our experience, we have found that the tar roads generally require a light surface treatment every two or three years, whereas, the asphalt roads will heal themselves and go much longer without any surface treatment, if a proper grade of asphalt is used.

In many places it has been found that one half gallon to the square yard spread onto a tar road of one of the good asphalts and properly covered will last a considerable number of years.

This experience, not confined to Massachusetts but is the experience of a number of other States, where tar has been used, notably Rhode Island, where ten years ago they had their entire trunk road system constructed mostly of tar, and it went to pieces within five or six years because they were not given the money that was necessary to provide either for the patching or surface treatment, necessary to preserve the road.

They have got to rebuild and they are doing it, but on a few sections, where they used an asphalt surface the tar road has stood up to the present time in perfectly good order.

Approximate Cost of Road Materials

Prices are very hard to compare in different places. It may, however, serve as some indication for you if I give you a short statement of what the present prices are in the State of Massachusetts.

Our bids for surface asphaltic oils or for surface cold tar treatments for 1/3 of a gallon to a square yard covered, are from 9 to 10 cents to a square yard.

Our labor cost is about \$3.00 per day of eight hours. The asphaltic oil is costing about 9 cents per U. S. gal. spread upon the road. This would be done by the oil company by contract.

In old times our bituminous gravel or asphaltic gravel roads were frequently built from 35 cents to 50 cents per square yard for the surface in place, complete. This does not include any foundation, grading or even preparing the macadam bottom, that we usually used. The asphalt used at that time cost about 12 1/2 cents to 15 cents per gallon.

The bids to-day for this surface for either bituminous sand or bituminous gravel are from 95 cents to \$1.15 per square yard for the surface alone, complete.

We used to build the roads complete, except for drainage, foundation and base but including the 4 in. macadam bottom for from 85 cents to \$1.00 per square yard. To-day it costs from \$1.50 to \$1.70 per square yard.

The asphalt used in this work was about the same as to-day, 12 1/2 cents per gal. and it requires from 2 to 2 1/2 gal. for each square yd. of road surface complete. It requires from 20 to 24 gal. of hot asphalt for each cubic yard of gravel. The oil expands in heating about 1/7 for 350 degrees Fah. I am speaking entirely of the American gallon; the Imperial gallon is considerably larger.—Paper read at the Annual Convention of the Canadian Good Roads Association, Halifax, N.S.

MANY LARGE FIRES OCCURRED IN 1921

FIRE losses in Canada during the past year are estimated by "The Monetary Times" at \$29,987,510, against \$27,371,574 in 1920. This is the highest loss on record, with the exception of 1918, when the total of \$31,315,844 was reached. It is a per capita loss of \$3.33. There was an exceptionally large number of large fires during the year, though none of them amounted to a conflagration.

The results may be summarized as follows:

	1919	1920	1921
Average monthly loss—			
	\$1,933,970	\$2,280,964	\$2,498,959
Loss per capita—			
	\$2.90	\$3.42	\$3.33
Fire with damage of \$10,000 or over—			
	238	301	377

The Monetary Times' record for the past three years shows the following monthly losses:

Month	1919	1920	1921
January	\$3,915,290	\$2,637,850	\$2,237,900
February	1,091,834	1,859,575	2,735,500
March	2,154,095	1,795,200	2,112,200
April	1,080,070	3,229,500	2,510,700
May	1,785,130	2,001,819	3,811,350
June	3,337,530	1,424,310	2,303,400
July	1,118,377	1,420,850	2,860,250
August	1,374,495	1,857,800	3,014,860
September	1,940,272	2,480,185	2,410,300
October	1,023,288	2,467,901	2,189,790
November	2,339,870	2,769,800	1,818,750
December	2,047,496	3,386,475	1,952,600
Total	\$23,207,647	\$27,371,574	\$29,987,510

SASKATCHEWAN GOOD ROADS ASSOCIATION

FIRST steps towards the formation of a provincial good roads association for Saskatchewan were taken at a conference between members of the government, representatives of the associations of urban and rural municipalities, associated boards of trade and officers of the Dominion Good Roads association held in Regina recently. The conference was held in the office of the Hon. H. M. Hamilton, Minister of Highways, and was presided over by Hon. S. J. Latta, president of the Dominion Good Roads Association. After being in session for about three hours the members attending the conference decided to organize a provincial good roads association which would be made up of representatives of the leading organizations in the province interested in this work. To this end a small committee consisting of Hon. S. J. Latta, E. G. Hingley, L. A. Thornton and W. E. Dennison was appointed to go into the whole question and report at a later conference concrete proposals regarding the basis of organization.

REVIEW OF INVESTIGATION INTO DETERIORATION OF CONCRETE IN ALKALI SOILS

Dr. Thorvaldson Appointed to Take Charge of Research Work at University of Saskatchewan—Experiments Being Conducted—Details of Field Tests

AT THE annual meeting of the Engineering Institute of Canada held in Montreal, the following report was received from Prof. G. M. Williams, of the University of Saskatchewan, secretary of the Committee on Deterioration of Concrete in Alkali Soils:

An organization meeting of the committee as originally constituted was held at the University of Saskatchewan Saskatoon, April 23, 1921. A general discussion of the problem by the committee members, all of whom have been familiar with the effect of alkali on concrete for several years, indicated that there was complete agreement as to the course which should be pursued in the investigation. Since previous investigations have established the fact that the best of Portland cement concrete may not prove permanent under certain known exposure conditions, it was agreed that the main effort should be directed towards the chemical problems involved, including the constitution of cement and the chemical reactions the soluble salts and the constituents of the cement. There is at present little to be gained by an extensive series of exposure tests of concrete to field conditions and it was decided to limit this phase of the investigation to a limited number of concrete specimens which would later serve as a basis of comparison with future field work which might be planned as a result of the findings of the chemical laboratory.

It was further agreed that a physical chemist having the highest qualifications be obtained to direct and supervise the chemical research and steps were taken to survey the field of available men in that line of work. In order that the committee might have the benefit of the advice and experience of a number of chemists of the Prairie Provinces who are familiar with the alkali-concrete problem, the following were appointed to full membership on the committee:

Dr. J. W. Shipley, professor of chemistry, University of Manitoba; Dr. T. Thorvaldson, professor of chemistry, University of Saskatchewan; F. C. Field, city analyst, Calgary; A. G. Blackie, city analyst, Winnipeg; and J. A. Kelso, provincial analyst, Edmonton.

The above have since taken an active part in the work of the committee.

A second series of meetings of the committee was held in Saskatoon, August 10 to 12, 1921. After thorough consideration of the names of available chemists it was decided to ask Dr. Thorvaldson, a committee member, to take charge of this chemical research, which he accepted subject to the approval of Dr. Murray, president of the University of Saskatchewan. Dr. Thorvaldson has been directing the work of several assistants during the past year in connection with certain phases of the alkali-concrete problem and it was felt that he would be in a position to take active charge with a minimum of delay. The University of Saskatchewan has since agreed to this arrangement and in addition to offering all of its available facilities to advance the progress of the investigation, has freed Dr. Thorvaldson from all class work, so that beginning with January, 1922, he will devote all of his time to the research.

Field Tests

Following the intention of the Committee that a limited amount of field investigation be started during the summer of 1921, concrete block specimens for exposure tests were molded in the Concrete Laboratory of the University of Saskatchewan for exposure to alkali soil waters at points in Alberta, Saskatchewan and Manitoba.

These specimens are cylindrical in shape, 7 in. in diameter and 21 in. long, molded in sheet metal forms. Two qualities of concretes were employed, having strengths of approximately 1,200 and 2,500 lb. per sq. in. at 28 days.

Canada and Super brands of Portland cement were used. Three different aggregates were used for each of the above cements and qualities of concrete, gravel used in commercial work in the vicinity of Winnipeg Saskatoon and Strathmore, Alta.

After preliminary tests of the cements and aggregates, batches of concrete were carefully proportioned and mixed by hand and test specimens were cured in moist air for 27 days after 24 hours of hardening in the forms. From each batch of concrete prepared, there were molded not less than six large exposure cylinders, three 6 by 12-in. compression test cylinders, and two slabs, for permeability tests of the concrete. All obtainable data, such as characteristics of cement and aggregate and weights of each used, were noted for further study.

In addition to plain concretes listed above, other batches were prepared using various waterproofing and alkali-proofing compounds suggested by the committee members and different manufacturers, as well as "Commercial" cement, a natural cement manufactured near Winnipeg. Some waterproofings are of the integral type while others are liquids or bituminous coatings applied to the surface after curing is completed. Each batch of concrete molded was given a series number. In all, 28 series or batches were prepared. Before shipment all specimens were wrapped in heavy paper and crated separately for protection.

Shipments of 56 test cylinders (28 series) were made to the following points early in September for exposure to alkali conditions:

Cassils, Alta.—One group was placed in a heavy alkali tract of land near Cassils, Alta., in a locality which has been used for several years by the Department of Natural Resources, C. P. Railway, for similar experiments.

Grandora, Sask.—One group was placed along the shore line of a sulphate lake near Grandora, Sask., about 14 miles west of Saskatoon.

Winnipeg, Man.—A group was placed along the aqueduct of the Greater Winnipeg Water District at a spot where analyses showed the ground water concentration to be highest.

At Cassils, Alta., the ground water table is only slightly below the ground surface and the blocks were embedded with about 6 in. projecting. At Grandora, Sask., the same scheme was employed. At Winnipeg the water table was found about 8 ft. below the surface, which necessitated the excavation of the soil to a depth of 8 ft. in an area about 50 ft. square.

A systematic method of securing samples of the alkali waters during the period that the ground remains unfrozen has been adopted, and the inspection of the condition of the individual blocks will be made at least twice yearly, in the spring and in the fall.

The Portland Cement Association is at present conducting extensive field experiments in the United States and is co-operating with the work of our committee by furnishing groups of 82 blocks each for exposure at the above three points. These have been installed alongside our own blocks and will be given the safe inspection. Super Cement (America) Ltd. has also furnished a number of small test pieces made in their laboratory, which have been placed with the large blocks.

Chemical Research

Since September three graduate students holding bursaries from the Honorary Advisory Council for Scientific and Industrial Research have been working on certain phases of the problem. The laboratory work so far done is of a preliminary nature concerned mainly with the action of the various salts under consideration on some of the simpler substances in cement and concrete. A considerable quantity of equipment specially adapted to this investigation has been ordered and is now being delivered.

In September Dr. Thorvaldson made a trip to Washington, D.C., and conferred with the members of the Cement Division of the Bureau of Standards and the research workers in the Geographical Laboratory of the Carnegie

Institution on questions relating to this investigation. The bulk of the advances so far made in America as to the constitution of cement has been accomplished at these two laboratories and it was therefore considered important to ascertain what work on this subject they proposed to continue and correlate our work with theirs. We look forward to a cordial co-operation with these institutions.

To date difficulty has been encountered in obtaining a trained assistant for the petro-graphical work. This phase should be carried on along with physical, chemical and colloidal examinations of the disintegration of concrete. In addition to the foregoing and the graduate students whose services will continue, additional assistance will be required and is now being arranged for, and the force of trained research workers will be increased as rapidly as the different phases of the investigation unfold during the next few months. As stated above, Dr. Thorvaldson is now devoting his full time to conducting and carrying on the chemical investigation.

INSTITUTE BRANCH SECRETARIES MEET

A MEETING of the branch secretaries of the Engineering Institute of Canada was held at the headquarters on Mansfield street, Montreal, on Jan. 26, lasting all day, for a general discussion of affairs. J. L. Busfield, secretary of the Montreal branch, presided, and there was a large attendance of secretaries of branches from Sault Ste. Marie, to Halifax and St. John.

Arrangements were discussed for greater co-operation between the various branches, plans for facilitating interchange of speakers at branch meetings, the standardization of branch by-laws, and ways and means by which the branch secretaries could give better personal service to the members of the various branches of the institute, thereby assisting in the promotion of the interests of the institute, its members and the profession generally.

The party was entertained at luncheon at the Engineers' Club, by J. A. Duchastel, and J. D. Farmer, chairman and vice-chairman, respectively, of the Montreal branch.

Those present included Messrs. K. G. Cameron, Sydney, N.S.; D. S. Cox, Halifax; H. F. Bennett, St. John, N.B.; M. J. Murphy, Moncton, N.B.; D. F. McLaren, Peterboro, Ont.; F. B. Goedike, Toronto; W. G. Wright, London, Ont.; Rex Johnson, Niagara Falls; J. C. Keith, Windsor, Ont.; J. Barnhill, Sault Ste. Marie, and Fraser S. Keith, general secretary of the Engineering Institute of Canada.

EXPECT DEMANDS FOR ROAD GRANTS

GROWTH of the use of motor vehicles in Canada is leading to a demand for increase of the Federal highways grant, and it is likely that deputations from many sources will make their appeals to the Government for increase in that grant, before the expiration of the present agreements.

In 1919 the Federal Government set aside \$20,000,000 to be expended on highways construction during the next five years, this amount to be allotted to the various provinces on a basis of 40 per cent of the cost of approved highway projects. So far all the provinces except Alberta have taken advantage of the grants, and the Federal Government's share of the estimated cost of projects under agreement to the end of last year was \$11,699,066, well over half of the entire sum set aside for five years.

The provision of a Federal grant has had the effect of stimulating highway construction in all of the provinces and it is felt in many quarters that if no further funds were provided there would be at least a temporary halt in the provincial roads construction plans.

Motor vehicle registration throughout the Dominion is stated to have increased almost 500 per cent from 1914 to 1921 and this year, it is expected the increase of the last few years will be borne out by the new statistics which are in the process of collection. It is because of this growth of motor traffic that the demand for better highways throughout all the provinces has increased, and automobile

associations in various parts of the Dominion have urged that the Federal Government should take steps before the present legislation expires, to provide for either a continuance of a similar grant or an increase.

LARGE TURBINE DESCRIBED

AT THE afternoon session of the Engineering Institute of Canada convention at Montreal on January 25, Julian C. Smith, vice-president and general manager of the Shawinigan Water & Power Co., gave an interesting paper on the design and construction of the new 41,000 h.p. turbine unit, which the delegates had inspected in the morning at the plant of the Dominion Engineering Works, Rockfield.

Mr. Smith's paper was illustrated by lantern slides, and was of a technical character. He stated that this unit had by far the greatest capacity of any single-runner unit installed in the province of Quebec, and was second only in power output to the new units now commencing to be operated at the Queenston-Chippawa plant of the Hydro-Electric Power Commission of Ontario. Mr. Smith gave a complete description of the new unit.

The chair was taken by John T. Farmer, vice-chairman of the Montreal Branch, and a vote of thanks was passed to Mr. Smith for his paper.

HALIFAX ENGINEERS APPOINT OFFICERS

THE second annual meeting of the Association of Professional Engineers of Nova Scotia met in the Green Lantern, Halifax, N.S., on Thursday evening, Jan. 19. It took the form of a supper meeting, with business afterwards.

This Association was incorporated by Provincial Statute on May 26, 1920, and now includes a membership of 243 engineers, representing every branch of the engineering profession, such as civil, electrical, mechanical, mining, etc.

In addition to other important business, the following officers were elected to fill the vacancies in the Council for the year 1922: Pres., C. E. Dodwell, district engineer, Department of Works, Halifax; vice-pres., George D. MacDougall, chief engineer, British Empire Steel Corporation, New Glasgow.

Councillors—F. R. Faulkner, Professor of Civil Engineering, N.S. Technical College; K. H. Smith, chief engineer, Hydro-Electric Commission, Province of Nova Scotia; D. H. McDougall, vice-president British Empire Steel Corporation, New Glasgow; C. H. Wright, manager, Canadian General Electric Co., Halifax; A. F. Dyer, chief engineer, N.S. Construction Co., Halifax.

At the Welland Hotel, St. Catharines, Ont., the Niagara Peninsula branch of the Engineering Institute of Canada held a meeting and dinner. A feature of the evening was an illustrated lecture on "Rural Power Distribution in Ontario" delivered by J. W. Purcell of the Ontario Hydro-Electric Power Commission.

The members of the Chatham City Council, the County Council and the directors of the Corn Fair were the guests at a noonday luncheon given on Jan. 25 at Chatham, Ont., by the directors of the Chamber of Commerce for the purpose of discussing good roads. Speeches were delivered by County Clerk Fletcher, W. G. McGeorge, Kent County Engineer, and R. O. Wynne-Roberts, of Frank Barber & Associates, Ltd., Toronto, showing the importance of undertaking an extensive program of road improvement in Kent County this year. Mr. Fletcher pointed out that Kent County had spent \$570,000 on good roads in the county last year, but the people must become educated to the fact that a great deal more money is necessary to be spent before the roads of Kent are in good shape.

NEW DEVELOPMENTS IN ELECTRIC POWER

Long Distance Transmission Has Now Become Practicable —International Relations As Affecting Power— —Broader Market for Power in Future

IN an interesting article in the "Monetary Times Annual" for 1922, Mr. Andrew T. Drummond deals with the new developments in electrical power in Canada: The newer developments in the electrical transmission of power, under which there is a strong probability that industrial centres five hundred and perhaps even one thousand miles distant from a great waterfall will, with relatively moderate loss in efficiency, be able to utilize the power from this fall, must now convince our governments and industrial leaders that in its numerous power sites Canada possesses facilities for developing its varied resources which should carry it to the forefront of manufacturing countries. These powers are by no means limited to the two millions and more horse power, it is expected, will be possible on the Canadian side of the St. Lawrence River, when the United States and Canada unite in developing the ocean highway between Montreal and Lake Ontario; and to the probably one million two hundred thousand horse power which is being, or can still be, developed within Canadian waters at Niagara Falls without lessening the scenic beauty of the surroundings. Millions of further horse power are available within our country.

Not every water fall or rapid is adapted for the development of energy. The head obtainable may be sufficient, but the natural conditions of the surrounding land may present a direct barrier, or be such that the cost of the work would not be compensated by the power obtained. The volume of water obtainable may be uncertain during the dry midsummer months, and there may be no facilities for forming reservoirs to hold back the spring floods and heavy rains, and let the surplus waters down, from time to time, to equalize the flow. Steam power derived from coal is the only present competitor of importance, but the existing high prices of coal, the cost of its transportation, and the expense and deterioration consequent on the necessary storage of huge quantities in order to provide for the winter months, all militate against coal, in comparison with the more convenient, clean and instantaneous electric energy, when delivered direct to the factory, or to the municipal distributing station within the city or town.

Power Resources

The United States claims, among nations, to have the largest amount of potential and developed water power, but when the important rivers of Canada falling into the Pacific ocean, the Arctic Sea, Hudson Bay, the North Atlantic Ocean, and the Gulf of St. Lawrence have been explored, and their falls and rapids have, in their height, volume and flow, been measured, there is no reason to doubt that the United States must easily yield the place to Canada. Much of the Dominion, in its far northern and north-eastern areas, including Labrador, and the entire country north of the Transcontinental Railway and the Saskatchewan River, is still unknown, except in, what might be termed, unconfirmed outline. Within these extensive limits of probably three thousand miles by twelve hundred miles, there are at least fifty rivers which are in magnitude from two hundred miles in length, onward to that great artery, the Mackenzie River, which, as it expands in its downward course, into a system of large lakes and connecting rivers, covers probably one thousand eight hundred miles. A few of these rivers, especially in Alberta, north of the railways, where, in the shadow of the Rocky Mountains, they, like the Athabasca, take their rise, have been recently surveyed in a general way, and their numerous rapids, and ample, but occasionally fluctuating, water supply taken note of. Others of these rivers are not only unsurveyed, but have been little known, except in a general way, to Hudson Bay, however, pass through country, the altitude of which above the sea is from 750 ft. to 2,000 ft. and upwards, these altitudes strongly suggesting that, in the reaches of these rivers lower down, power will be available.

Thus—to illustrate generally these northern rivers—where the Transcontinental Railway crosses Ontario and Quebec, and beyond the height of land, from which, among other streams, the following rivers flow northward to Hudson Bay, the altitude above the sea of the Nottaway River is 775 ft.; the Missinabi, 717 ft.; the Kenogami, 756 ft.; and the Albany, 1,177 ft., and these rivers, whilst having ample volume, are, excepting the Albany, of relatively only moderate length. In Alberta, the Athabasca River, where it is crossed by the Grand Trunk Pacific Railway, is 3,311 ft. above the sea level, at Lesser Slave Lake it is 1,899 ft., at Athabasca Landing 1,550 ft., and at Fort McMurray, after in the last eighty miles developing about twenty rapids, it is 817 ft. and the Athabasca and its lake expansion form part of the great Mackenzie system.

The Yukon, again, is a large river, taking its rise under other names in Canadian territory, where, at the confluence of the Lewis and Pelly Rivers, it is 2,965 ft. above the sea, and at Dawson City on the main stream, is still 1,200 ft. As another illustration, Wollaston Lake, on the height of land to the westward of Hudson Bay, is 1,300 ft. above the sea, and, apparently, at the source of Seal River, which through perhaps 250 miles, courses its way to that bay. Explorers have from time to time referred to falls and rapids on some of these streams, but excepting possibly, in the case of the Athabasca and Nelson Rivers, on the latter of which it is claimed that three of the rapids will develop over 3,500,000 horse power, the estimates, where any have been made, have been, in perhaps all cases, very roughly formed, and generally from information supplied by other parties, and with no impression of value being attached to them for power purposes. Nevertheless, all the known facts enable us to take it for granted that on these rivers, so many of which flow into the Arctic Sea and Hudson Bay, will be found a huge amount of potential energy, amounting to some millions of horse power, most of which, by reasons of distance and climate, must, for the present, remain undeveloped.

Long Distance Transmission

There is however, a future, and perhaps even an early future, for some of these powers, and long distance transmission will be an important factor in securing this. There are large deposits of iron, copper, coal, and other minerals, not explored in detail, but known to exist, in our north land, the mining of which, and all the chemical and metallurgical industries associated with this mining, will necessarily require inexpensive power. It is also suggestive that with the great cost of transporting coal to the central sections of the Transcontinental Railway in Northern Ontario and Quebec, and the nearness of important water powers there, it is worth investigating whether hydro-electric power would be any advantage. And we might even look further into the future. In this age of wonderful discoveries we must be prepared for the accomplishment of what may, at first sight, seem absolutely beyond the capacity of the human mind to grasp. The hopeful thought may just now rest in the imagination, but if, by some happy discovery, which may yet come, heat on a large scale can economically result from electric power, for use in our homes to replace coal and wood, the vast energy of our northern rivers which are distributed so lavishly over half a continent, may, with its varied resulting conveniences, ultimately prove to be another providential plan of the Creator which would help to lessen the rigors of the long winter months and make this north land a shade more habitable. Apart from these possibilities, there is the suggestion that industries requiring large amounts of power, like the production of nitrogen from the air, and of wood pulp, where the mills can still be conveniently close to the spruce forests, might also, through long distance transmission, utilize some of these northern powers.

Great Market For Power

Canada, as a manufacturing country, has attained a new status. There is no longer a reason why our governments should regard it as, primarily, an agricultural country, and why it should give encouragement only to the im-

migrant who will settle on the land. It is quite true that the western prairies as well as our eastern farms need many more men of that class, but our manufacturing industries now produce more value in output than the entire agricultural production of the country. With vast, and in many cases, untouched resources, supplemented by magnificent water powers which which to work them into exportable products, and by ample transportation facilities, we want direct encouragement to be given to men of initiative, enterprise and capital from Great Britain and the United States to co-operate with Canadians in developing these resources. We also want the skilled workmen to man the manufactories that must follow.

To export the raw material, and thus furnish work for scores of thousands of skilled men in other countries, instead of having manufactories to build up our own, has been one of Canada's serious mistakes in the past. Even the hydro power itself at Cedar Rapids on the St. Lawrence, and at Niagara Falls, and on the Rainy River, was permitted by the Dominion to be exported, like a raw material, to the United States, instead of the government compelling the American manufacturers—when such an opportunity presented itself—to locate on the Canadian side of the rivers and make their establishments the centre of busy industrial towns here. Even if the market for their manufactured goods was claimed by Americans to be chiefly in the United States, the much less expensive power, and the otherwise lower average cost of, at that time, producing such goods in this country, would have enabled these manufacturers to, perhaps entirely, pay the American duties, whilst, in addition, they could export from this side more cheaply than through United States ports. Conditions during, and since the war, have become greatly changed here both as to the home and export trade, and with large preferences now conceded throughout the Empire to Dominion products, there is a clear advantage to United States industrial works to establish branches in Canada. About six hundred of these are already located in, especially, Ontario cities and towns, and more are coming. In the face of this fact, there are still people in our country who have such limited vision and enterprise as to approve of the further export of power to the United States. It will be greatly to our discredit if we fail to take advantage of this special means of building up our country.

General Electric's Discovery

Two hundred and fifty miles are the extreme distance to which hydro-electric power has been thus far profitably transmitted. The recent discovery at the General Electric Company's laboratories at Schenectady, New York State, that one million volts are possible, will, it is there believed, enable the power current to be sent to distances double, and perhaps quadruple, the present maximum. The effect of this in our prairie provinces, for instance, would be remarkable, wherever the raw material could be laid down at low cost, and a sufficiently large market for the products could be found, and provided cheap coal did not interfere. The possible 104 ft. fall at Grand Rapids, where the Saskatchewan River falls into Lake Winnipeg would have within economical range, in the distribution of its power, such cities and towns as Regina, Saskatoon, Battleford, Prince Albert and scores of smaller places between Grand Rapids and the United States boundary line, whilst following the lead of Ontario, the advantages of power and light could be within the reach of thousands of farmers for use in farming operations. Similarly, Alberta, down to the United States boundary line, could be reached by the energy of the Athabasca River, should Calgary require, as is probable, for its own use the whole of the Bow River power.

Use on Railways

Electric power, as applied to railways, appears, thus far, to have its limitations. The steam roads which have for some years been experimenting with it on their lines, have confined its use, as a rule, to special work, as in tunnels, on grades through the mountains, and on work at terminals. On the other hand, the electric roads, with a quarter of a century of experience behind them, have only

given a limited attention to freight, which on the steam roads is the larger and much more profitable part of the traffic. With few exceptions, both in the United States and Canada, interurban electric roads have not proved profitable enterprises. They appear to be best adapted to passenger transport through very populous districts immediately surrounding large cities, or from city to city where these are very close to each other, and where, in each case, a very frequent service can be given with a certainty of large advantage being taken of it.

Hydro-electric power has, during recent years, been of assistance, but nothing can overcome the result to the railway of a limited population. The most attractive problem still to be solved in Canada is whether, with abundant, electrically-transmitted water power, it would be profitable to the railways and assist business, to electrify sections of the older steam roads, where, as in parts of Ontario, they pass through fine, productive districts possessing fair sized cities and towns in proximity to each other, the electric trains to take both freight and passengers. This is quite a different question from the building of new electric roads. The railway has been in operation for probably half of a century, a large business has been gradually developed, and it is only a case of further advantage being gained by the relatively light added cost of electrifying. From the steam road point of view the proposal is practicable, and, under certain conditions, would appear to be applicable to one or two branch lines of the Grand Trunk Railway in Ontario. The experience gained there would be of value in considering the electrifying of other sections. Should the Dominion Government assume, as it certainly should, its rightful control over all the international and navigable waterways of the country, including in this the whole St. Lawrence system from Lake Superior to the sea, the government railways will have ample opportunities of obtaining the necessary hydro-electric power.

Government Jurisdiction

The clear intention under the Imperial British North America Act of 1867 was that the Dominion should have the control of all international and navigable waters throughout Canada, and of the water powers developed upon them. For reasons difficult to understand, the Canadian Government has hitherto failed to realize the direct bearing upon trade and commerce which these water powers have. Especially has this been the case since transmission to great distances has become effective in helping to cheapen the cost of production among manufacturers, and to greatly expand trade, particularly by inducing manufacturers in the United States and Great Britain to establish branches of their works in this country. Further, at the present time, when new sources of revenue are so important, there could be obtained, without directly taxing the people, a large annual return, amounting to many millions of dollars from a reasonable charge for each horse power developed. The writer has repeatedly brought the subject of the Dominion rights, and the possible revenues from them, before different departments of the government.

What is wanted is a definite policy in regard to all water powers upon international and navigable rivers, under which they would be controlled by the Dominion in the interests of navigation, industries, railways and civic and domestic convenience, and would only be leased and at a fair annual rental, payable to the government, for each horse power of possible development. Finding no direct assertion of rights by the Dominion Government, the Ontario Government has actually assumed control of the power at Fort Francis on the Rainy River, at Sault Ste. Marie on the St. Mary's River, and at Niagara Falls, and has made claims to the undeveloped power of the St. Lawrence River below Prescott. It has further endeavored to fortify by acts of its own legislature much of what it has done. All this is of recent date, the first actual development of power under authority from it, materializing only in 1902.

Had the Dominion Government established a National Park at Niagara Falls, as it should have done, and was invited in 1880 by the Ontario Legislature to do, instead of

allowing, by its neglect, the Ontario Government in 1885 to undertake the work, simply as a park, and with no thought of water power development, there is no question that we should never have heard of Ontario's rights in water powers. The forthcoming report of the International Waterways Commission on the deepening of the St. Lawrence with a view to an ocean highway, and the action which the United States Congress and our Parliament at Ottawa take in regard to it, must necessarily bring to the front all questions as to Dominion and Provincial rights in both international and navigable waters. The Ontario Government may, however, rest assured that the heavy indebtedness which it has incurred in connection with Niagara Falls developments will, under any circumstances, be carefully guarded in the interest of the bondholders.

GOOD YEAR EXPECTED IN BUILDING TRADE

AN optimistic outlook for the building industry during 1922 was reflected in the proceedings of the annual meeting of the Builders' Exchange, Toronto. That the contractors are looking forward to a season of prosperity during the coming months was indicated in the various reports, especially that of Secretary George Gander, and the views expressed by different members.

The general attitude was that the only thing now needed to bring about a marked revival of activity in building in Toronto was a reduction of wages paid to the building trades to conform with the lowered costs of materials and contractors' profits. In this connection it was decided to launch a publicity campaign to place before the public the builders' views respecting the questions of wages and agreements which have restrictions regarded as a detriment to the building industry.

A resolution was passed also strongly protesting against the payment by the City Council of the 60 cents an hour rate to unskilled labor on the ground that such a wage was extreme.

In reviewing the conditions under which the builders of Toronto start the New Year, Secretary Gander stated:

"I feel safe in saying that prices are as near rock bottom as possible. We have the latest report of an institution which is continuously building, that their costs during one year have dropped 35 per cent. You then should have no hesitation in convincing the architect and owner to put their plans on the table at once and receive a pleasant surprise with estimates that are moderate in the extreme.

"Many expensive building propositions have been laid aside during 1919 and 1920 and office and house building is far behind the needs of to-day. It would be far better that these people start at once for we reasonably feel that a rush later on would only result in delay in delivery of materials."

The report points out that during 1921 no building proposition was abandoned because of prices being too high, each job being inside the architect's estimate.

In dealing with various matters affecting the building industry Mr. Gander says: "We do not agree with the Provincial Government in appointing a Labor man as vice-chairman of the Compensation Board. This office should have been filled by a non-interested party; as it is now, labor has representation and employers none, which is class legislation in every sense of the word."

Attitude of Labor

In the annual report of retiring president J. M. Scott, reference is made to the dealings with labor during the past year, special mention being made of the conferences of the various parties interested held in Ottawa last May and in Toronto in July, "solely for the purpose of trying to bring about a general reduction in building costs in order to help to stimulate the trade."

"As you are aware," the report comments, "labor rejected every proposition, even in the fact of the Minister of Labor's address wherein he warned them that the time had come for serious consideration of the question, yet they turned a deaf ear to all his suggestions. During the year

the wages of stonecutters, carpenters, lathers and laborers have been reduced. The other trades are still very high, but we trust will be so settled as to make the public or the investor feel satisfied that they will receive a fair return for their investment.

"The public cannot see eye to eye with the unions' one dollar per hour mark. This is to them like a red flag to a bull and a change from the dollar sign would be an easement to their feelings. We might just as well acknowledge the fact that for 1922 'The Public' will be the sole arbiter of extreme prices in the building trade, and lower prices are the only kind of an olive branch they will accept.

"I say truthfully that so far as contractors are concerned their competition of the present day keeps them from being blamed for high prices."

The report states that costs of materials have decreased considerably during the latter part of 1921, and remarks that had wages and materials been more moderate earlier in the season more work would have been gone on with.

Officers elected for 1922 were: President, W. H. Painter; First vice-president, W. Carmichael; Second vice-president, John V. Gray; Directors, James J. Brown, Edward Teagle, C. F. Till, Charles Bulley and J. M. Scott.

ENGINEERING INSTITUTE ELECTIONS

AT a meeting of the Council of the Engineering Institute of Canada, held recently in Montreal, the following elections and transfers were announced:

Members—J. F. Bell, Toronto; E. V. Buchanan, London; C. F. Draper, Montreal; F. W. Farncomb, London; D. E. Grant, Montreal; Thomas Montgomery, Sarnia.

Associate Members—R. De B. Austin, Toronto; C. W. Brown, St. John; R. E. Butt, Hamilton; H. B. Fisk, Drummondville, Que.; N. F. Harrison, St. Boniface; J. A. Laniel, London; T. E. McGrail, Ottawa; W. A. Robinson, Winnipeg; W. G. Scott, Montreal West; Sidney Snell, Toronto; T. L. Tait, St. Lambert, Que.; James Weir, Montreal; S. R. Weston, St. John.

Associates—W. C. Franz, Sault Ste. Marie; D. L. McKeand, Ottawa; D. M. McLean, Sherbrooke.

Juniors—A. D. Bishop, Windsor; J. B. Garneau, Quebec; W. C. Goodwin, St. John; C. A. Grupp, Waterdown, Ont.; F. S. Hartle, Winnipeg; T. H. Henry, St. Catharines; F. J. Igoo, Peterborough; G. D. Maxwell, Toronto; W. C. E. Robinson, Coldwater, Ont.; Keltie Wilson, St. John; K. M. Winslow, Winnipeg.

Transferred, Associate Members to Members—E. G. Horne, Montreal; P. O. G. Jones, Toronto; Ibbotson Leonard, London; C. J. H. Townsend, Toronto; L. W. Klingner, Bagdad, Mesopotamia.

Transferred, Juniors to Associate Members—A. A. Anderson, London; H. G. Angel, Bassano, Alta.; C. M. Barnes, Buffalo, N.Y.; B. C. Berry, Toronto; P. R. Boese, Ely, Nevada; Fitzjames Bridges, London; B. M. P. John, Montreal; L. W. Deslauriers, Montreal; S. D. Fawcett, Ottawa; C. E. Fraser, Toronto; M. C. Garroni, Winnipeg; Walter Griesbach, Montreal; G. A. Jenkins, Portland, Oregon; S. R. Keemle, Chatham; A. J. Kelly, Montreal; H. F. Morrissey, St. John; C. B. Shaw, Iroquois Falls, Ont.; O. H. Shenstone, Toronto; R. H. Stenhouse, Ottawa; H. H. Vroom, St. Lambert, Que.

Transferred, Students to Associate Members—C. W. Boast, Richmond, Que.; E. C. Cowan, Winnipeg; C. H. Donnelly, Niagara Falls, Ont.; H. I. Dowling, Toronto; Alan Ferrier, Montreal; L. F. Mackay, Montreal; D. K. McLeod, Toronto; W. M. Miller, Mansfield Park, Uckfield, Sussex, England; Rosenorn Paul Emil Mathias, Montreal; F. E. Weir, Beamsville, Ont.

Transferred, Students to Juniors—W. H. Bennet, Kenora; E. J. Buckingham, Winnipeg; J. C. Elder, Montreal; L. E. C. Frith, Winnipeg; P. G. Gauthier, Montreal; T. S. Glover, Toronto; D. J. Ludgate, Pakesley, Ont.; A. E. Macdonald, Halifax; B. H. T. Mackenzie; James O'Halloran, Iroquois Falls, Ont.; B. C. Salamis, Montreal; R. D. Stiles, Pictou, N.S.; J. L. Underhill, Sydney Mines, N.S.

LEADING PROBLEMS NOW FACING CANADIAN CONSTRUCTION INDUSTRIES

Good Work Accomplished by Executive Committee — Subjects Discussed Included Apprenticeship, Code of Practice, Contract Documents, Purchasing Orders, Etc.

By J. Clark Reilly

Executive Secretary, Association of Canadian Building and Construction Industries

THE hard work of the pioneers in the formation of the Association of Canadian Building and Construction Industries is beginning to bear fruit. Following our Winnipeg Conference in January, 1921, the men in Manitoba, Saskatchewan and Alberta got together and formed a Western Branch, which will meet again in March. In the Province of Quebec a Provincial Association has been formed, fathered by D. K. Church and F. G. Brousseau. Branch associations have been formed at Port Arthur, Port William and at Prince Albert.

The Executive Committee has carried the burden of the work during the year, and has accomplished a great deal. Too much credit cannot be given to the members for the unselfish manner in which they have travelled to the meetings and conducted the association's affairs. It should be made public that, with one exception, the members paid their own expenses, both railroad and hotel, not only when attending Executive Committee meetings but also at meetings of the Joint Conference Board.

The following meetings of the Executive were held: March 2, at Ottawa; March 15, at Toronto; April 28, at Montreal; May 11, at Toronto; June 21, at Toronto; September 15, at Montreal; November 2, at Hamilton; and December 13, at Toronto. Messrs. Anglin, Carswell and Grieve attended eight meetings, Mr. Pigot seven, Mr. Matice four, and Mr. Whitlock one. The western members of the Executive have been kept constantly in touch with the work done, and have rendered valuable assistance by suggestions through correspondence.

At the conference in Winnipeg a number of questions were sent forward to the Executive for action, and these have been dealt with, so far as was possible under conditions existing in the industry during the year.

It was not found practicable to employ an associate secretary to devote his time to the interests of the manufacturing and supply section, and the trade contractors' section, owing to the lack of the required funds. Stenographic assistance was given to the secretary, however, and a separate office obtained and suitably furnished.

The question of housing, acted on by resolution at Winnipeg, has been carried forward by the Executive to the Government, but the difficulty of financing such a scheme proved to be the stumbling-block in the way of its success. The need still exists.

The National Joint Conference Board, of which last year's Conference approved, has held five meetings, as follows. The first in Ottawa, March 2 and 3; second, third and fourth during the Joint Conference in May; fifth in Ottawa, delayed meeting from December, held January 10. The recommendation regarding financing this Board has not as yet been acted upon, our members continuing to pay their own expenses.

A Joint Conference in the building and construction industry of Canada was held at Ottawa, May 3 to 6, on the invitation of the Minister of Labor, who acted at the suggestion of the National Joint Conference Board. Some thirty-two employers' delegates from all parts of Canada met a similar number of representatives of organized labor.

Apprenticeship is still a question on which but little practical results are apparent in the working out of the schemes proposed for National and Local Councils, and also in the actual signing on of boys for the trades in the industry. The foundations have been laid, however, and when conditions improve the need of apprentices will be more strongly felt than ever.

The resolutions of last year's Standard Practices Com-

mittee were sent out to branch organizations throughout the country, and have been discussed and acted upon in some places. There does not seem to have been any very special enthusiasm over establishing rigid Codes of Practices, and yet difficulties constantly arise in the relations of general contractor and sub-contractor, and of both to the supply-man.

Representations were made to the Dominion and Provincial Governments in regard to the re-imbursment of contractors who had suffered loss owing to war conditions, and also in reference to the resumption of public works to relieve unemployment.

Joint consideration, with the Executive Committee of the Ontario Provincial Association, was given to the question of the Ontario Lien Law, and other legislation affecting our industry coming before the provincial legislature.

The standard contract documents approved at last conference have been placed before the Royal Architectural Institute of Canada and the Engineering Institute of Canada, for their approval, but these bodies apparently do not wish to take action at present. Copies have been typewritten and distributed on request, and the General Conditions and Straight Contract have been used on some large contracts, and found practical and satisfactory.

It has also been suggested that we might consider some standard form of bulk purchasing order, this being in the nature of a contract form.

The association was represented by the president at the annual meeting of the Employment Service Council of Canada, at which the question of unemployment was the principal subject under discussion. The Dominion Government, in conjunction with the provincial governments and municipal authorities, is carrying out some of the suggested plans of the board. There is still a great measure of unemployment in the large centres of Canada, and as an association we should give the most careful consideration to this very pressing problem.

The question of freight rates is still with us. Some relief has been given to conditions by the reduction allowed by the Board of Railway Commissioners, but there remains much to be said and done in regard to the rates on heavy commodities, in which the construction industry is so directly concerned.

The time of the secretary during the year has been very fully occupied in carrying out the work laid down by the Winnipeg Conference, the Executive Committee, and the new matters which seem to keep constantly arising. Every effort has been made to keep expenses as low as possible, and this has been a difficult matter in view of the high costs of printing, stationery and other necessary materials. In addition, there has been a great deal of further work arising from the sessions of the National Joint Conference Board and the Joint Conference in May last, and this has been done by the secretary.

Conditions have not permitted any extensive travelling for organization purposes, the trips taken by the secretary being those necessary for attendance at meetings of the executive committee, and two others in regard to renewals of memberships in Montreal and Toronto.

It is to be noted that the branch organizations are making increasing use of the secretary in Ottawa to secure information from various offices of the Government, and this is also the case with individual members of the association. The secretary has tried to keep in touch with matters which have come up, affecting the interests of the association, both in the late session of the House and in the resulting application of the legislation.

One of the needs felt by the Executive and the secretary is the obtaining of statistics dealing with various questions which arise, and for which we have not the facilities.

There is still the necessity for the uniformity of legislation in the various provinces of Canada. This is especially true of the Workmen's Compensation and the Lien Acts.

Speaking generally, the year 1921 has been a very notable one for building and construction in one respect at least. The attention of the various governments, the press,

the pulp and the public has been directed very intensely towards the industry, both in the United States and Canada. This has been due in a large extent, to the widespread publicity given to three outstanding reports, viz., the Lockwood Inquiry in New York City, the Report of Judge Landis in Chicago, and what is known as the Hoover Report on the Elimination of Waste.

Through these reports, and the resulting discussion and other more direct and practical effects, public interest has been aroused in practically all of the great questions which we have had before us. The causes for the high cost of labor and materials, the shortage of housing, the seasonal character of the industry, the tightness of money, the attitude of labor organizations, the results of agreements between employers and organized labor, the causes of waste, and the need for greater stability and standardization have all been under discussion.

The Hoover Report contains some clauses which are very striking, and which may be found applicable to Canadian Conditions:

"Waste, it is said, is causing huge losses in building, which, including all trades and labor incidental to it, ranks second among the industries."

The chief sources of waste in the building industry are irregular employment, inefficient management and wasteful labor conditions. Customs or conditions prevailing throughout the industry and poorly designed equipment are given as secondary causes."

"A striking fact about the building industry is that inasmuch as small buildings require so little capital and credit, and apparently so little technical ability, the field is full of small contractors, many of whom operate for a few years, and then fail."

"Wasteful labor regulations, according to the report, consist of requiring skilled men to do work which could be done by unskilled, restricting individual incentive through requiring uniform wages, limiting the number of apprentices, excessive reduction of working hours, restricting output by prohibiting the use of labor-saving devices, and jurisdictional regulations."

The responsibility in which we share is well emphasized by the following clause in the general manager's address, at the recent annual meeting of the Canadian Bank of Commerce:

"The excessive cost of building operations has made it impossible up to the present time to embark on an operation of such magnitude as is necessary to meet our requirements. In this connection it may be pointed out that in all parts of Canada there is a large program of building in prospect, the carrying out of which only awaits more stable conditions in the form of lower prices for material and labor and a return to efficiency."

The past year has been a time of difficulty and uncertainty, but it is our business to face the future with confidence, and do our utmost to solve the problems, and bring about a return of those conditions which will mean a revival of activity in our industry.—From annual report presented January 17 at the Conference of the Association in Hamilton, Ont.

GEORGIAN BAY CANAL ADVOCATED

WHILE the project to provide a great international channel for ocean-going ships by improving the St. Lawrence river to the Great Lakes is being studied by the government of Canada and the U. S., proponents of an alternative plan, the proposed Ottawa and Georgian Bay canal, are seeking to enlist support for their all-Canadian waterway.

Advantages claimed for this route over the St. Lawrence ship canal include its position entirely within Canadian territory, its immunity from the storm hazards of the lakes and the savings it offers in mileage.

According to reports of Canadian government engineers who have made an exhaustive study of the project, the Ottawa and Georgian Bay canal scheme is practicable.

As surveyed, the canal would follow the St. Lawrence from Montreal to the junction of the Ottawa and St. Lawrence rivers; there the Ottawa would be followed to Mattawa and Lake Nipissing and the French river would provide outlet from the Ottawa river to Lake Huron.

The length of the canal would be 440 miles with a lockage of 758 feet, the number of locks being 27 with lifts ranging from five to 50 feet. The size of the locks would be uniformly 650 feet in length, 65 feet clear width and 22 feet depth. Twenty-two feet would be the maximum depth on the entire length of the waterway. This waterway would consist of 28 miles of canal proper, 66 miles of improved river navigation and 346 miles of river and lake varying in width from 300 feet to half a mile.

As in the case of the proposed St. Lawrence-Great Lakes scheme, power development is planned. Government engineers have estimated that on the Ottawa and French rivers it will be possible to develop 1,000,000 horsepower. The power developed at the famous Chaudière falls at Ottawa, already the centre of large industrial operations, would be doubled.

Under the Ottawa and Georgian Bay scheme, vessels of twenty-foot draft, or 15,000 tons displacement, would ply between Montreal and Lake Superior ports. Advocates of the plan argue that this would make for increased inter-provincial trade, as Nova Scotia colliers might take their cargoes 1,000 miles into the interior from Montreal and load cargoes of grain and other interior products for the return voyage.

INCINERATORS DISCUSSED BEFORE THE TORONTO BRANCH, E.I.C.

AT THE meeting of the Toronto branch of the Engineering Institute of Canada, January 26, R. R. Knight, of Francis Hankin & Co. addressed the branch on "Incineration," or the practice of destruction of garbage by heat. A large number of lantern slides were shown to explain the various types of equipment used.

The desirability of utilizing the fuel value of garbage to bring about its own destruction was stressed by the speaker. An average of about one-fifth of a ton of garbage per capita per annum may be expected from a large community, and since one pound of garbage may be considered as capable of evaporating one pound of water in addition to the three-quarters of a pound present in the garbage, the heat value of this material is evident. The speaker stated that it possessed about one-quarter of the calorific value of poor coal.

Mr. Knight expressed the opinion that reduction of garbage for the utilization of various constituents thereof was impracticable for cities of less than 500,000 population. The destruction of garbage by incineration was also regarded as impracticable, without the use of added fuel, for cities of less than 15,000 population.

According to the speaker, there should be no nuisance experienced from well-managed incineration plants, especially in a city of appropriate size. Frequently these are placed alongside a public building, such as a hospital, and the heat derived from the combustion is used for the generation of power. At least 40 tons of garbage per ten hours should be available in order to make power development practicable.

Mr. Knight stated that an incinerator plant for a city of about 20,000 people would cost about \$30,000.

Complete statistics available show that during the fiscal year the Federal Department of Public Works spent \$20,970,674.31, of which \$1,217,892.07 is charged to demobilization. As compared with the total for the previous year, even with a reduction in the war expenditure of over \$3,000,000, there is an increase of \$15,214.46, due principally to the expenditures made on harbor and river works at Courtney Bay, St. John, N.B., Toronto, Fort William and Port Arthur, and Esquimalt, B.C.

HEAVY TRUSSES USED IN NEW YORK STOCK EXCHANGE EXTENSION

Interior of Twenty-four Storey Building Carried on Four Trusses Weighing One Hundred and Fifty Tons Each
— Ingenious Method of Erection

A VERY difficult piece of engineering was successfully carried out recently in the addition to the New York Stock Exchange. The new building is twenty-four storeys high and situated north of the present eight storey structure. When designing the extension the architects imposed unusually severe demands on the structural engineer by suppressing an entire storey of interior supports and asking him to carry more than twenty storeys over a large hall. This was accomplished by using four very heavy trusses weighing about one hundred and fifty tons each.

Due to the importance of the lower floors it was found necessary to raise the trusses up to the space between the fifth and sixth floors; the third floor and fourth, or mezzanine floor, being hung from the lower chord of the truss. The sixth floor frames into the top chord and the fifth into the bottom chord of the truss making a distance of 15 ft. 10 in. between centres of chords. The size of the supporting columns and the spread of the foundations made it necessary to keep these columns further back from the wall than the upper exterior columns. To do this the end posts of the trusses were inclined outward, the end panels thus forming a cantilever on which are carried the upper wall columns.

The columns and the main truss members are similar in design. They are made up of a 14 in. 287½ lb. Bethlehem H-section, being the web of the member, with three 24 x ¾ in. plates on each side. Where heavier members were required 8 x 6 x ¾ in. angles and filler plates were added. The heaviest member was composed of 1-14 in. H @ 287.5 lbs., four angles 8 x 3½ x ¾ in., eight angles 8 x 6 x ¾ in., two plates 8 x ¾ in., two plates 41 x ¾ in., four plates 34 x ¾ in. and two plates 34 x ¾ in. The main truss members were made with 1½ in. rivets and other minor connections with 1 in. rivets.

The erection of these heavy trusses at such a height was a very difficult task but it was ingeniously accomplished by using the steel work for the upper part of the building. Beams and columns designed for the upper stories, were used up to the ceiling of the large hall and above this point the hangers for the third and fourth floors were erected and used as columns to support the bottom chord which was erected in its permanent position. The floor framing was then put in and used as a platform to erect the rest of the truss after which the temporary steel below the third floor level was removed. The heaviest unit to be handled was the main section of the top chord which weighed 53 tons. The total weight of structural steel used was about 5,660 tons and the trusses are probably the largest ever used in office building construction.

WOULD INCREASE DIVERSION AT NIAGARA FALLS

BY way of explanation of a recent statement that an application by American interests was before Congress to have 100,000 cubic second feet of water diverted from the Niagara river above the falls, Sir Adam Beck says that at present Canada, by treaty, is entitled to 36,000 cubic feet per second. The United States is permitted to take 20,000 cubic feet per second. The total diversion to-day is 56,000 cubic feet second. The proposal now being made is to increase the diversion to 100,000 cubic feet second, an increase of 44,000 c.f.s. Of this, Canada would get 22,000 c.f.s., and the United States 22,000 c.f.s.

Hitherto the Americans have talked of making an equal division of all water taken from the falls, including the increased diversion, and this Canada was prepared to fight strenuously, as the existing division of water favoring this country was due to the United States getting a large quantity of water from the Great Lakes for the Chicago

drainage canal. Were the equal basis followed, Canada would get only 14,000 c.f.s. of the increased diversion and the United States 30,000 c.f.s.

Canada's share of 22,000 c.f.s. of the increased diversion would produce more than 600,000 horsepower of electricity, the maximum capacity of the Chippawa Canal if carried through the canal to Queenston. Canada is still wasting about 4,000 c.f.s. of its present allotment and with that water and a new interpretation of the treaty, sufficient water to operate the Chippawa Canal to maximum capacity could be obtained without the proposed new diversion, Canada's consent to the increased diversion has to be secured.

TESTING EFFECT OF ALKALI ON CONCRETE

IN AN address at the annual convention of the Saskatchewan Agricultural Societies Association Walter C. Murray, president of the University of Saskatchewan drew attention to the research being conducted at the University of value to the farmer. There were for instance, experiments being conducted in the matter of the effect of alkali on concrete, which were being carried out by the members of the science faculty. If a solution were found to the problem of the destruction of concrete by alkali it would mean the saving of millions of dollars annually in the west. Much progress had already been made and it had already been discovered that the question was one of chemical, not of physical, effect. Numerous experiments had already brought out the fact that the quality of concrete was not an element in the question.

PHONE COMPANIES PLAN YEARS AHEAD

TELEPHONE company engineers plan from fifteen to twenty years ahead in installing equipment, with the result that it is seldom necessary to dig up a conduit to increase its capacity. This was one of the interesting statements made to members of the Montreal Branch of the Engineering Institute of Canada by N. M. Lash, chief engineer of the Bell Telephone Co., in an address at a meeting held recently in Montreal.

Because telephone systems grow the cost per unit of giving service does not decrease, the speaker said. As more subscribers are added more intricate and expensive equipment is required and costs go up. He dealt with the subject of the long-distance telephone system, stating that the open wire will soon be replaced by wires in cable to care for heavy demands. The actual productive talking time on long distance was also discussed, and it is said that the time is constantly being increased as a measure of economy and operating efficiency improved, but each advance along these lines called for bigger expenditure on new equipment.

The annual meeting of the Ontario Good Roads Association will be held in Toronto, March 1, 2 and 3.

The Illinois section of the American Waterworks Association, of which G. C. Habermeyer is secretary, will hold its 14th annual meeting at Urbana, Ill., on March 23 and 24.

We desire to call our readers' attention to an error which appeared in the January 24 issue of "The Canadian Engineer." In the report of the Canadian Building and Construction Industries Convention at Hamilton, on page 164, reference was made to several reels of industrial films exhibited by the Austin Mfg. Co. This should have read the Austin Machinery Corporation of Chicago, makers of the well-known Austin cube mixers and road building machinery. We might add that this line of machinery is made in Canada by the Canadian Austin Machinery Co., at Woodstock, Ont.

LUMBER PRICES ARE INCREASING

THROUGHOUT the year 1921, although the general tendency of the wholesale lumber market was downward, the principal construction woods—yellow pine, North Carolina pine and Douglas fir—held fairly firm and the prices in eastern market centres today are virtually on the same level as they were at the beginning of 1921, according to A. R. Kriebbaum, vice-president of Lumber, who attended the convention of the Canadian Lumbermen's Association, at Toronto.

In reviewing the year's market, Mr. Kriebbaum pointed out that the market was on a downward trend when the year opened and this decline continued, almost without interruption, until about October 15. Then buying was resumed on a fairly large scale and prices began to climb slowly, continued upward until December 1st, when they struck an even keel, and have remained about that level ever since. In the hardwood department, however, the advance did not begin until late in November, and hardwood prices today are still rising.

Heavier Demand and Higher Prices

While the contemplated demand during the spring and summer will undoubtedly result in the stiffening of prices, the advance is not expected to be very rapid, and certainly prices will not even approach the peak level of 1920. To again reach such an abnormal level would not be to the best interests of the lumber industry or the public at large, and the lumber producers and wholesalers themselves full realize this.

Competition for business will be keener in 1922 in the lumber business as it will in all other lines of industry and this will tend to hold values to a reasonable level. It should be remembered, however, that for more than a year the lumber producers have been selling their products at very little profit and in numerous instances below cost of production. The volume of business for 1921, taken as a whole, was small and many mills have been closed down for months. To resume operation and re-enter the market, these mills must be assured a reasonable price for their lumber. Otherwise they will remain shut down.

The conclusion which at present seems definite, therefore, is that the wholesale price of lumber in the east today is considerably lower than it will be sixty and ninety days hence. The construction lumber market is bound to advance above its present level, and the hardwood market is already advancing.

VICTORIA HARBOR ASSOCIATION ISSUES REPORT

THE annual report of the Inner Harbor Association of Victoria, B.C., which has just been issued, gives some interesting information regarding the improvements which have been carried out and which are still being made. It states that about 3,000,000 cubic yards of rock, hard pan, mud and gravel have, so far, been removed from the navigation channel, at a cost of \$1,500,000. The work of deepening the turning basin, involving the removal of approximately 100,000 yards of clay and rock is now in progress, as well as the removal of shoal spots in the fairway west of Songhees Point, so as to maintain the harbor grade to twenty feet below low water mark.

The old tortuous entrance to the Inner Harbor has been straightened and widened from Hospital Point westward, forming a channel with a minimum width of about six hundred feet, and twenty feet deep at zero low water. This great work of development is now being followed up by continuing the removal of Hospital Rock, which has always fouled a large area of water on the east side of Songhees Point.

The southerly approach to the new Johnson Street bridge has recently been improved by the removal of the easterly portion of Discovery Rock, which abutted into the channel, and the approach at this point has been made clear.

The Dominion Government has built and completed the breakwater and docks at Ogden Point, and is now building

the drydock at Skinners Cove, Esquimalt, at a cost of \$4,300,000. This dock will, when finished, increase the importance to shipping on the Pacific Coast of this port.

NEW BRUNSWICK ENGINEERS ELECT OFFICERS

THE annual meeting of the Association of Professional Engineers of New Brunswick was held on Jan. 27 in the Board of Trade rooms, St. John, N.B. Reports were received from the various officers. The council report showed that the association has a membership of 179. C. C. Kirby, retiring president, gave an interesting address. The election of officers was held and resulted as follows: President, S. B. Wass, Moncton; vice-president, C. C. Kirby, St. John; secretary, J. A. Waring, St. John; Councillors, St. John District, F. P. Vaughan and H. F. Bennett; Moncton District, J. D. McBeath, Moncton, and K. S. Pickard, Sackville; Fredericton District, B. M. Hill; Chatham District, R. J. Sly.

NEW YORK COMMISSION OPPOSES ST. LAWRENCE PROJECT

A COMMISSION appointed by Governor Miller of New York to oppose the Great Lakes-St. Lawrence River waterway project has filed with the Legislature its second report. This was divided into two parts. First, a memorandum of the commission based on the report of the engineers, and, second, the address of Governor Miller before the Atlantic deeper waterways convention at Atlanta, Ga., last November.

In its memorandum the commission opposes the St. Lawrence project on the grounds that:

Plans and estimates of engineers for the St. Lawrence improvement from Montreal to Lake Ontario are preliminary only, and that the data submitted is not sufficient to indicate that the work can be done for the amount stated.

New York State will not voluntarily surrender its vested rights in the water power along the St. Lawrence.

Whatever water power is available belongs to the State of New York and the Provinces of Quebec and Ontario, and that neither the Dominion of Canada nor the United States Government can lawfully appropriate them without compensation to the owners.

In order to produce 4,100,000 horsepower and a 25-foot channel, the United States and Canadian Governments will have to spend more than \$488,000,000; for a 30-foot channel, with the same amount of horsepower developed, the cost will exceed \$506,000,000.

Operation of the waterway will be hampered by ice and flood conditions.

It is unwise for the two Governments to tie up their natural resources in such a project.

New York State protests against the use of the potential property interest of the state in the undeveloped St. Lawrence River waterpower for the financing of the plan under consideration.

The expenditure by the United States of the money necessary to make the St. Lawrence River navigable for ocean-going vessels of 25 or 30-foot draft is not justifiable.

An outstanding improvement in the operation of Canadian railways was registered in October, 1921, when, in spite of decreased freight and passenger business transportation, expenses were cut \$4,896,904, or 21 per cent. over the previous month, according to information issued recently by the transportation branch of the Dominion Bureau of Statistics. The Canadian Northern, Canadian Government and Grand Trunk Pacific Railways all showed marked improvements in their operating ratios, and for the first time in two years, instead of expending from one to two dollars in operating expenses alone in order to earn one dollar, these roads expended 90.6, 92.7 and 94.4 cents respectively, for each dollar earned. The C.P.R. showed the lowest operating ratio this year, namely, 69.56 per cent, as against 69.46 per cent. for October, 1920.

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LAKE OF THE WOODS CONTROL CONTROVERSY GROUNDLESS

IN A recent issue announcement was made of the promulgation in the Canada Gazette of regulations covering the mode under which the Lake of the Woods Control Board must regulate the levels of the Lake of the Woods pursuant to the Lake of the Woods Regulation Act passed at the last session of Dominion Parliament. The question of adequate provision for the best use of the Lake of the Woods waters to meet the needs of all interests on both sides of the international boundary, which a few months ago tended to become a violent political controversy, would appear now happily to be in a fair way to satisfactory and permanent settlement.

So far as the physical or engineering problems involved in the whole question are concerned, and they have been exceedingly complex and have taxed the ability of leading engineers in both countries, there never has been real difficulty in reaching a solution which would meet the practically unanimous approval of all the engineers concerned. When, however, attempts were made to put into actual effect the provisions for the carrying out of the solutions agreed to as feasible and advisable from an engineering standpoint, legal impediments incident to conflicting international, federal, provincial and state rights became so pronounced that those in most intimate touch with the issues have despaired of ever reaching a conclusion which could be made acceptable to the governments of Canada and the United States as the basis for a treaty settling permanently all the matters arising from the Lake of the Woods reference. Especially was this so when an unnecessary conflict of opinion arose between the Dominion government and the Ontario government as to the modus operandi for furnishing the control of the levels and the out-

flow of the Lake of the Woods within the limits of the range recommended by the International Joint Commission, and which was conceded to be a matter entirely for appropriate action by competent Canadian authority.

Strange to say, both the governments at Ottawa and Toronto were in complete accord as to the main purpose and even the general method of securing such control, but largely because of the resistance of certain interests at the outlet of the Lake of the Woods, the Ontario Government was forced to recede from the scheme agreed to with the Dominion government to provide by joint and concurrent legislation for a Lake of the Woods Control Board. Upon the failure of the co-operative scheme, the Dominion government decided, largely upon the urge of the government of Manitoba, to bring down the Lake of the Woods Regulation Act, which, by invoking the "general advantage" clause of the British North America Act, furnished the requisite authority for providing precisely that species of control contemplated by the previously agreed to concurrent and conjoint legislation of Parliament and Legislature.

It has been publicly stated that the Dominion legislation went further than was absolutely necessary, when the "general advantage" clause was applied to the control of the levels and outflow of Lac Seul, an important body of navigable water which is not international, and therefore in an entirely different category from the Lake of the Woods. There would, however, appear to be justifiable reason for the inclusion of Lac Seul under similar control to that of the Lake of the Woods. It certainly has a very direct and under conceivable circumstances, a dominant bearing on the regulation of the waters of the Winnipeg river. Indeed it would be very easy for an unsympathetic or antagonistic private purpose plant to be set up on the English river involving control of the outflow of Lac Seul waters in such a way as to destroy entirely the beneficial effect of the dependable flow furnished from the Lake of the Woods.

In such case, power developments on the Winnipeg river in Manitoba would be menaced to a degree which would react to the permanent disadvantage of a vast and important key industry for the whole province of Manitoba. Plants of the city of Winnipeg, the Winnipeg Electric Railway Co. and the project now under way of the Manitoba Power Co., involving capital expenditures of nearly \$20,000,000, and many times that amount of directly dependent capital outlays, would be placed in an impossible position and their proprietors might be forced to pay unjust toll to the private purpose plant controlling the outflow of the English river. No government either of the Dominion or of the provinces of Ontario or Manitoba could, under any conceivable circumstance, permit such a condition of affairs. Therefore, it would appear that it was a justifiable and timely move on the part of the Dominion government to include Lac Seul within the purview of the Lake of the Woods Regulation Act. As this Act provides a means for its withdrawal upon the passing by Ontario of its joint concurrent legislation, there is a very definite and simple means of solving the whole control problem.

It is understood that shortly after Royal assent was given to the Lake of the Woods Regulation Act, the Meighen government re-appointed thereunder the original Lake of the Woods Control Board, which was constituted by Order in Council on 21st January, 1919, by and with the consent of the Ontario Government. "The Canadian Engineer" is informed that this Board is now functioning satisfactorily and that the regulations recently promulgated were prepared for and recommended to the Dominion government by it. The board should now be in a position to provide that regulation which representatives of the governments of the Dominion and of the Provinces of Ontario and Manitoba were at one time in unanimous agreement about. So far as the international aspect of the whole problem is concerned, we are advised that the recommendations of the International Joint Commission have been formally accepted by the governments of Canada and of the United States in a general way, but that certain minor

amendments made necessary by investigations since the Commission's findings were completed in 1918 are now the subject of international negotiations. It is confidently expected that in the near future these negotiations will reach a stage where it will be possible for a complete agreement to be reached upon which a treaty or convention can be based. It would therefore appear that the report and recommendations of the International Joint Commission on the Lake of the Woods reference matter, will in due course be given effect to in a permanent way by the governments of Canada and the United States. An active international controversy of long standing and fruitful of real trouble to both countries will then have been composed by the good offices of the Commission.

PERSONALS

F. J. Ure, C. E., town engineer of Woodstock, Ont., has been appointed engineer and surveyor for East Zorra Township.

W. H. FERRIS, Reeve of Harrow, Ont., has been appointed chairman of the highway committee of the Essex County Council.

DR. W. H. SUTHERLAND, M.P.P., in the provincial legislature has been appointed Minister of Public Works for British Columbia.

S. L. SQUIRE, chairman of the executive of the Canadian Good Roads Association has returned to Toronto from Victoria, B.C., where he has been making arrangements for the annual convention of the association to be held in Victoria on June 13-16.

W. O'BRIEN, of the Canadian Bridge Co., Walkerville, Ont., has arrived in Victoria, B.C., and will direct operations on the construction of the highway section of the Johnson St. Bridge. Mr. O'Brien, who is a well-known bridge engineer, was superintendent of construction of the south end of the Quebec bridge.

FRED J. WOLFE, who at the annual meeting of the Imperial Oil Company held a few weeks ago was elected to the directorate has been a member of that organization for more than twenty years, having begun his business career as junior clerk in the office of the Queen City Oil Co. in Toronto, 1901. In 1904 Mr. Wolfe was placed on the sales

staff and his ability and energy were soon recognized and he was made city agent for London, Ont. In 1905 he moved back to Toronto to occupy the position of assistant to J. P. Rogers who was at that time manager of the lubricating branch of the Queen City Oil Co. In 1914 Mr. Wolfe became assistant sales manager for Ontario and in 1918 was made sales manager of the Western Ontario District. He remained there until

1920 when he was transferred to Montreal and took charge of the sales of the province of Quebec. In 1921 he was appointed general sales manager in the Toronto office of Imperial Oil Co., Ltd.



A. E. DOUCET, director of public works, city of Montreal, has written a letter to the executive committee asking that his resignation be accepted, to take effect, Feb. 1. Mr. Doucet was appointed to the position of Director of Public Works during the late administrative commission's regime. During his term of office many improvements in civic service were inaugurated.

OBITUARIES

C. HOWARD ELLIS, of Ellis & Ellis, architects, Toronto, died in that city on January 27, aged 37.

HENRY H. MARSH, contractor of Grimsby, Ont., died in Hamilton on January 27. Mr. Marsh was born at Winona, Ont., 63 years ago.

GEORGE EDWARDS, 80 years of age and said to be the oldest living science graduate of McGill University, was accidentally killed recently at Cold Lake, Alta., where he was engaged in the lumbering business.

NEW PUBLICATIONS

REPORT OF THE MINISTER OF PUBLIC WORKS for the Province of British Columbia year 1920-1921. The report contains one hundred and eighty pages of detailed information regarding the public works carried on by that department together with a number of interesting plates illustrating the various works.

IROQUOIS ASPHALT PAVING MACHINERY. This brochure contains interesting descriptions together with illustrations of the various machines produced by the Iroquois Department of the Barber Asphalt Company including asphalt mixing plants of the semi-portable and stationary types, melting kettles, road rollers. The brochure is very nicely illustrated and printed on heavy coated stock.

CONCRETE WORK. Vol. 2 — By William Kendrick Hatt, Professor of Civil Engineering, Purdue University, Lafayette, Ind., and Walter C. Voss, head of the department of Architectural Construction, Wentworth Institute, Boston, Mass. Published by John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London. 206 pp; 5 1/4 by 7 1/4 in.; 37 figures; cloth; \$2.25 postpaid. Reviewed by H. S. Van Scoyoc, Manager of Publicity, Canada Cement Co., Ltd., Montreal. This book is a companion publication to Vol. 1 by the same authors reviewed in these columns May 5, 1921. The two volumes are inter-dependent, Vol. 1 being a reference book for Vol. II. They are a unique contribution to the literature of concrete in that they include much of the information usually sought for in a handbook, much detailed information usually associated with a reference book, and a very definite treatment of practical problems arising in actual concrete building construction.

They do not replace the text books used in engineering schools but will be of great assistance in the secondary schools giving instruction in concrete work in their manual training departments. They will be of greater value to the ambitious employees of contracting firms who are interested not only in what they are doing but also in the principles underlying the methods that are followed.

The material included is really the outgrowth of the instruction given concrete workers in the vocational detachments of the United States Army at Purdue University during 1917-1918. It has had an intensive trying out and brings into an unusually compact form the accepted methods for testing the materials entering into concrete work, the construction of forms, methods for mixing and placing concrete, some basic problems in reinforced concrete design and detailed methods for the actual construction of sidewalks, concrete products and the simpler building units. Prof. Hatt has taken full advantage of his close association with the various technical and trade societies interested in concrete work and the books reflect the very latest information available on the subjects discussed.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

Construction news items, including notes of various tenders called, are published on pages 44 to 50 of this issue. The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported on the above-mentioned pages. The word "Issue" refers to the issue of "The Canadian Engineer" in which there appeared a notice giving some details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Edmunston, N.B., construction of a school building	Feb. 8	Jan. 31
Toronto, Ont., miscellaneous work on several schools	Feb. 8	Jan. 31
Ontario, Province of, Work on Provincial highway, Township of Ameliasburg ..	Feb. 10	Jan. 17
Victoria, B.C., fabrication and erection of part of the superstructure of Johnson Street bridge	Feb. 13	Jan. 17
Ontario, Province of, supply of Portland cement	Feb. 14	Jan. 24
Cap de la Madeleine Que., supply of pumping equipment	Feb. 13	Jan. 31
Kitchener, Ont., purchase and removal of brick buildings	Feb. 13	Jan. 31
Hespeler, Ont., erection of a public library building	Feb. 21	Jan. 31
Ontario, Province of, expansion joint material	Feb. 21	Jan. 31
Huntsville, Ont., construction of pavement	Mar. 1	Jan. 31
Ontario, Province of, construction of pavements, culverts, grading, etc.	Mar. 6	Jan. 31

BRIDGES, ROADS AND STREETS

Alberta, Province of.—Premier Greenfield told a delegation from the Canadian Good Roads' Association, which waited on the cabinet recently, that the Alberta Government would make every effort to take advantage of the Federal grant of \$1,500,000 for the building of highways in the province.

Brantford, Ont.—The estimated expenditure on roads in Brant county this year has been set by the County Council at \$275,000. Road Superintendent, A. M. Jackson, Brantford.

Calgary, Alta.—Plans and specifications are being prepared for the construction of a bridge over the C.P.R. irrigation ditch on Seventeenth Ave. east. City Engineer, George W. Craig.

Charham, Ont.—A tentative promise to pave seven miles of Provincial Highway in Kent County this year was made by Hon. F. C. Biggs, Minister of Public Works and Highways, to a deputation from here recently.

Galt, Ont.—The estimate of Waterloo County Council this year for road construction is \$300,000. Road Superintendent, L. S. Lichty, Wellesley, Ont.

Guelph, Ont.—The City Council intends to construct concrete pavements on the following streets: Metcalfe, Alice and Queen. Total estimated cost, \$59,754.50. City Clerk, H. J. B. Leadlay.

Hamilton, Ont.—The City Council passed the by-law for the extension of the Mountain roadway to James St., which was approved by the ratepayers recently. City Engineer, E. R. Gray.

Kingston, Ont.—The City Council has decided to open Mack St. to Regent St. City Engineer, Howard S. Dick.

Kingston, Ont.—Frontenac County Council plans to expend \$109,700 on roads this year. Road Superintendent, R. H. Fair, R. R. No. 5, Kingston.

Lindsay, Ont.—Victoria County Council awarded the contract to Frank King, of Lindsay, for the removal of approximately 2,000 cu. yds. of solid rock and other work at Fenelon Hill. Eight tenders were received, ranging from \$4,450 to \$8,737.50.

Ontario, Province of.—A delegation from the Niagara district municipalities will have a conference with Hon. F. C. Biggs, Minister of Public Works and Highways, regarding the commencement of the work on the Hamilton-Niagara Highway at an early date.

Ottawa, Ont.—Authorization for the borrowing of a half million dollars for the construction and maintenance of good roads, and for current expenses, was granted Carleton County Council recently. County Road Supt., Samuel McClure, Galetta, Ont.

Owen Sound, Ont.—It is proposed to build a bridge over the harbor in order to connect up the C.P.R. tracks to provide interswitching facilities. Both railroads are opposed to the scheme, but the city is in favor of it. The whole matter will shortly come up before the Railway Commission. Three schemes have been proposed, the most feasible being a bridge north of 10th Street, which will cost about \$40,000.

Quebec, Province of.—Work may soon be commenced on the construction of the Ile Perrot bridges, the western from Vaudreuil to Ile Perrot and the eastern from Ile Perrot to St. Anne de Bellevue. The Provincial Government has already voted \$600,000 for this work and the Dominion Government has agreed to contribute \$150,000. The Vaudreuil-Ile Perrot bridge will probably be of reinforced concrete and the St. Anne de Bellevue-Ile Perrot bridge of steel construction.

St. Thomas, Ont.—Elgin County Council has estimated its share of county road expenditures for 1922 at \$75,000, with the possibility of the amount being increased in June, if the construction program is enlarged. The sum of \$20,000 will be spent for road construction, \$35,000 for maintenance, \$10,000 for culverts and bridges, \$5,000 for gravel pit development, and \$5,000 for machinery. Road Superintendent, Frank Pineo, St. Thomas.

Sandwich, Ont.—Essex County Council passed a by-law authorizing the borrowing of \$400,000 for road construction during the year. Road Superintendent, W. H. Kinster, Sandwich.

Sandwich, Ont.—A by-law was passed by Essex County Council authorizing the borrowing of \$400,000 to expend on county road building this year. Road Superintendent, W. H. Kinster, Sandwich.

Sarnia, Ont.—A by-law was introduced at a recent meeting of Lambton County Council to provide for the building of 1½ miles of concrete road on the 16th sideroad of Sombra Township, the estimated cost being \$40,000. County Road Supt., John McCallum, Alvinston, Ont.

Toronto, Ont.—The City Council intends to extend and grade Edgewood Ave. at an estimated cost of \$11,750.

Toronto, Ont.—The City Council proposes to acquire lands for the extension of Simpson Ave., from Logan Ave. to Carlaw Ave.

Toronto, Ont.—The Transportation Commission asked the Board of Control to provide a temporary bridge on Gerrard St. during the construction of the proposed high-level bridge over the Don.

Toronto, Ont.—The Works Committee recommended the adoption of the report of Works Commissioner Harris for the construction of an asphalt pavement on Chestnut Park Road at a cost of \$49,989.

Toronto, Ont.—Works Commissioner Harris has recommended the construction of curbs on the following streets; Burgess Ave., Kenilworth Ave., Glenmount Park Dd., Glenlake Ave., Patricia Road, Belhaven Road, and Battenburg Ave.

Toronto, Ont.—Works Commissioner R. C. Harris has recommended the construction of pavements on the following streets; Glenlake Ave., \$20.079; lane 1st west of Markham St., \$6.009; lane 1st east of Sacville St., \$2.057; lane 2nd south of College St., \$2.508. Also the following cement concrete sidewalks; Lawler Ave., \$5.222; Lawton Ave., \$12.42; Oriole Gardens, \$1.161; Pince Crest Road, \$2.857; Strathmore Blvd., \$4.417; Windermere Ave., \$3.233.

Toronto, Ont.—Additions to the York County good roads system are under consideration by York County Council. The following sections are proposed: Kipling Avenue, New Toronto, from the Toronto and Hamilton Highway to the G.T.R., $\frac{1}{2}$ mile; Vandorf Road, $\frac{1}{2}$ mile to Vandorf Village and to G.T.R. Station, Albion Road, from Thistletown to Peel County Good Roads; Dufferin Street, from the city limits to connect with Vaughan Road; Queen Street east, to be connected with Kingston Road, 3,000 ft.; Sharon Road, $2\frac{1}{2}$ miles, to connect Holland Landing with Sharon also simultaneously to connect Simcoe and Ontario systems and avoid a seven mile detour.

Victoria, B.C.—The Canadian Bridge Co. of Walkerville, contractors for the highway section of the Johnston St. Bridge are assembling equipment and a considerable portion of the steel that will be required is already on the ground. W. O'Brien is in charge of the work.

Whitby, Ont.—The expenditure of Ontario County Council for good roads in 1922 will total \$88,700. Road Superintendent, D. J. Kean, Whitby.

Whitby, Ont.—The route of the Whitby to Lindsay Provincial highway has been definitely decided upon and the plans deposited in the Registry Office here. Work will likely start in the spring.

York Tp., Ont.—The Township Council plans to extend Hillary Ave.

WATER, SEWAGE AND REFUSE

Chatham, Ont.—Mayor Harrington who recently visited Stratford to inspect the incinerator there, will report to No. 3 committee of the City Council on the practicability of constructing an incinerator here.

Kingston, Ont.—The City Council has decided to have sewers laid in Regent and Mack Streets. City Engineer, Howard S. Dick.

New Toronto, Ont.—An application is being made by the Municipal Council to the Ontario Government for approval of the construction of a sewer from Second St. to the eastern town line. Clerk, W. H. C. Millard.

Peterborough, Ont.—Waterworks Superintendent R. L. Dobbins in his report showed that by the commission laying its own pipes in connection with the filtration plant, over \$18,000 had been saved. Contracts for the plant were let for \$304,813, and to the end of December, \$219,936 was expended.

Port Credit, Ont.—On the advice of the Provincial Board of Health, the four lake shore municipalities west of Toronto—Port Credit, Etobicoke, Mimico and New Toronto—are working together to arrange for a common water system.

Toronto, Ont.—Tenders will be called for the construction of sewers in the Leslie gardens subdivision, estimated to cost \$40,000.

Toronto, Ont.—The Works Committee reduced the estimate of Works Commissioner Harris, amounting to \$2,021,000 for sewers, to \$500,000.

Toronto, Ont.—The Board of Control recommended that the proposed water works emergency station and storehouse at the northwest corner of Dundas St. and Hamilton

St., estimated to cost \$14,000, been erected by day labor under the supervision of City Architect Price.

Toronto, Ont.—The Board of Control awarded contracts to Angelo Cavotti for the laying and jointing of water mains in Woodington Ave., at \$1,143; Stratmore Boulevard, \$594.56; Wolverleigh Boulevard, \$590.60; Milverton Boulevard, \$588.12 and Glebeholme Boulevard, \$589.11.

Toronto, Ont.—Works Commissioner Harris has recommended the construction of the following sewers: Macpherson Ave., \$3,880; Foxbar Road, \$11,630; lane -st east of Sackville St., from Salisbury Ave. to Amelia St., \$1,415; Ardagh St., \$9,195.

Toronto, Ont.—The Board of Control awarded the contract for construction of a sewer in Strathmore Boulevard, from Woodington Ave. to Glebeholme Ave., to the Murphy Contracting Co., at \$2,460. Contracts were also awarded to Ruscica Bros. Co. for the following sewers: Wolverleigh Boulevard, Woodington Ave. to Glebeholme Ave., \$2,199.92; Glebeholme Boulevard, Woodington Ave. to Glebeholme Ave., \$2,419.56; Milverton Boulevard, Woodington Ave. to Glebeholme Ave., \$2,030.40.

York Tp., Ont.—The Township Council received notice from the city of Toronto that 25 hydrants will be placed on Morningside, Kennedy Park Road and Runnymede Road.

LIGHT, HEAT AND POWER

Halifax, N.S.—A number of power developments are under consideration in this district. Investigations have been carried on at Bear River and Sheet Harbor, where 8,000 h.p. and 25,000 h.p. respectively could be developed. At St. Margaret's Bay 10,700 h.p. is being developed at the new power plant and at Mahone on the Mush-a-Mush River 16,000 h.p. is being generated.

RAILWAYS

Hamilton, Ont.—Plans for the construction of an incline railway up the side of the mountain at the head of Ottawa St. were presented to the Board of Control by T. H. Simpson, on behalf of a syndicate. Estimated cost, \$100,000.

New Westminster, B.C.—The Dominion Department of Public Works awarded the contract for the construction of repairs to groins Nos. 1 and 3 at Annville Bar, Fraser River, to the Fraser River Pile Driving Co., New Westminster, B.C., at \$6,432 (unit price).

Ottawa, Ont.—An order-in-council has been passed authorizing the expenditure of \$735,000 on steel rails for the government railways.

St. Catharines, Ont.—Thorold and Crowland Townships passed the by-law providing for the purchase of the Niagara, St. Catharines & Toronto Railway, while Humberstone and Grantham Townships defeated it.

St. John's, Nfld.—Sir W. G. Armstrong Whitworth company have been asked by the directors of the Newfoundland Products Corporation to act as their technical advisors in the development of the Humber River water powers and other projects. There is a total possible development of 235,000 h.p. on the Humber River and neighborhood. Surveys have been made by the Reid Co. engineers, and the plans have already been submitted to the engineers representing the Armstrong Whitworth Co., whom, it is understood, have made an estimated of the cost of development. Messrs. Armstrong, Whitworth will contract to supply all machinery and equipment for the power development and for a proposed pulp and paper mill, and will also carry out the construction work. The estimated cost of the whole development is about £4,000,000.

Toronto, Ont.—A resolution urging the Government to take action to hasten the electrification of the Midland branch of the Grand Trunk Railway and the Sudbury branch of the Canadian National System, will be introduced at a meeting of York County Council.

Toronto, Ont.—A new plan for radial entrances to the

city, alternative to that drawn up by the Hydro-Electric Power Commission, was explained to the North Toronto Ratepayers' Association at a recent meeting, by W. P. Chapman, and was endorsed by the association in principle. The plan provides for a central terminal between Edward and Dundas streets, and an open tunnel up the Teraulay street extension to another terminal at Belmont St. (Ramsden Park), then northwesterly along the C.P.R. to connect with the Guelph, Weston and Woodbridge lines. The Hamilton line would enter over the harbor development land to the new Union station and the Metropolitan by way of Bathurst street.

Windsor, Ont.—Plans for the Canadian Pacific Railway Company's proposed new freight sheds to be erected on Caron Ave. have been approved by engineers of the company. The work, which will involve an expenditure of at least \$250,000, will be started within two weeks.

Winnipeg, Man.—D. C. Coleman, vice-president of the C.P.R. in charge of western lines, announced that projected work of the company in Manitoba provides for a mechanical coaling plant at La Riviere, automatic signals at Sidney, and the improvement of water supply plants at Rathwell, McGregor and Wheatlands. Mechanical coaling plants will also be erected at Eagle River, Ont.; Estevan, Sask.; Swift Current, Sask.; and Medicine Hat, Alta. An additional ice-storage building will be erected at Okanagan Landing, B.C. and the water supplies will be improved at the following plants: Bredenbury, Hirsch, Frys, Weyburn, Macoun, Elbow, Parkbeg, Fauna, Outlook and Gull Lake, in Saskatchewan; Bow Island and Lundbreck, in Alberta; and Elko and Creston, in British Columbia. The new office building at Moose Jaw, and the extension to the Island coal dock at Fort William, will be pressed to conclusion, and a considerable amount of work will be carried on in the replacement and standardization of bridges on the line.

FACTORIES AND LARGE BUILDINGS

Athens, Ont.—The High School, recently destroyed by fire, will be rebuilt.

Brockville, Ont.—The Ontario Railway and Municipal Board has sanctioned the annexation by the town of Brockville of 125 acres in the township of Elizabethtown, where the plant of the Eugene F. Phillips Electrical Works, Ltd., will be erected.

Chingacousy Tp., Ont.—The Township Council plans the erection of an addition to the Township Hall. Clerk, Robert Kee, Cheltenham.

Courtenay, B.C.—R. Fraser Biscoe plans the erection of a theatre building.

Edmonton, Alta.—Plans for the alteration of the 101st Street market building into a technical school have been approved by the buildings and grounds committee of the Public School Board.

Guelph, Ont.—Plans and specifications for the new Collegiate and Vocational Institute will be completed by February 15, when tenders will be called for. Architect, Gordon Hutton, Hamilton.

Kingston, Ont.—The Board of Governors of the General Hospital awarded the contract for the construction of a new wing to the Dixie Construction Co.

Kitchener, Ont.—The Greb Shoe Co., Mansion St., plan the erection of an addition to their building this spring.

Lakeview, Ont.—The erection of a new school is projected.

Lambton Park, Ont.—The ratepayers of S. S. No. 33 authorized the trustees to issue debentures not exceeding \$55,000 for an addition to the school and playgrounds. Tenders will be called shortly. Chairman of School Board, A. Shaw.

Montreal, Que.—The premises of the Independent Last Co., 89 Marie Anne St., were damaged by fire to the extent of \$23,000.

Montreal, Que.—Contract for the supply and installation of all wrought iron work in Mount Royal Hospital has

been awarded to The Western Supply & Manufacturing Co., Pacific & Yeoman St., Winnipeg.

Mount Forest, Ont.—The members of St. Paul Church plan the erection of a parish hall.

North Toronto, Ont.—Plans for the erection of a new church building on the site of the present one were adopted at a recent meeting of the congregation of St. Clement's Anglican Church. Rector, Canon A. J. Fidler.

Ontario, Province of.—Instead of rebuilding the Kingston Dairy School recently destroyed by fire, the Provincial Department of Agriculture may build a modern structure at Kemptville in connection with the Agricultural College there, and disburse with the Kingston site.

Port Colborne, Ont.—Fire damaged the Maple Leaf Milling Company's building and machinery to the extent of \$15,000. The Maple Leaf Hotel was also badly damaged by fire.

Port Stanley, Ont.—The London & Port Stanley Railway Commission plans the erection of an amusement hall in the park here this spring. Tenders will be called at once.

Regina, Sask.—The Saskatchewan Motor Co., Ltd., plans the erection of a new plant.

Riverside, Ont.—The Town Council plans the erection of a new Municipal Hall and police quarters.

Riverside, Ont.—A by-law was passed providing for the raising of \$50,000 for the construction of houses. Clerk, C. J. McHugh.

Sandwich, Ont.—Recommendations that an industrial school for girls be built in Essex County, in addition to a new jail and isolation hospital, were contained in the presentment of the grand jury to County Judge J. J. Coughlin, at Sandwich.

Sarnia, Ont.—A new factory will be erected by Mackey's Bread Ltd. at a cost of \$30,000. Head Office, Toronto.

Scarboro Junction, Ont.—The ratepayers decided to issue debentures amounting to \$60,000 for the purchase of a school site.

Stouffville, Ont.—A movement is on foot by the Board of Trade for the erection of a library building. President, F. C. Hessel.

Toronto, Ont.—The members of St. Stephen's Anglican Church plan the erection of a memorial hall. Rector, Rev. T. G. Wallace.

Toronto, Ont.—Plans will be prepared at once by City Architect Price for the proposed Reception Hospital to be erected on Surrey Place.

Toronto, Ont.—Work on the construction of the new tabernacle of the Christian and Missionary Alliance, on Christie St., will be started at once.

Toronto, Ont.—A permit has been issued to the G. W. V. A. to erect a two-storey brick clubhouse on the north-west corner of College and Crawford Streets, at a cost of \$50,000.

Toronto, Ont.—The permit for the construction of the 11-storey building at the northeast corner of Bay and Temperance Streets for the General Accident Assurance Co. of Canada has been granted to the Sutherland Construction Co., Toronto.

Toronto, Ont.—The Board of Control recommended that the carpenter work on the new Northern Stables be carried out under the supervision of City Architect Price by day labor, the contractor to whom the contract was awarded having failed to carry same out.

Toronto, Ont.—Excavation has started for the erection of the new Church of the Resurrection, Milverton Boulevard and Woodbine Ave. The intention is to erect the main portion of the building at present, which will be added to as required. Approximate cost, \$32,000. Rector, Rev. E. Gillman.

Toronto, Ont.—Plans for the new church which will be built at Rushton Road and St. Clair Ave. are being prepared by the uliding committee of St. Clair Avenue Methodist Church. The new uliding will cost \$100,000, and the finance committee will launch a campaign shortly to raise the first instalment of \$45,000. Charles Summerfield is chairman of the building committee.

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

The Structural Design of Pavements

Sub-Base Consideration and Economic Depth of Foundation
—Pressure Distribution and Impact Effects Shown by
Tests — Drainage of Sub-Grade an Important Factor

BY A. T. GOLDBECK

Chief, Division of Tests, U. S. Bureau of Public Roads

FUNDAMENTALLY, a pavement is a structure acted upon by a bewildering array of forces. Its structural design is a complicated problem in mechanics, and ultimately we shall have to make use of the principles of mechanics if we ever hope to arrive at what seems to be a rational method of design. Let us consider briefly some of the forces to which a pavement is subjected.

In the first place, pavements may be roughly divided into two main types, those of the rigid and those of the non-rigid type. On both types the same external forces act, but the manner of their resistance and their effects are different, depending upon the characteristics of the pavement. The pavement structure, either of the rigid or non-rigid type, is a slab supported on the subgrade. The manner of its support is widely varying for this depends upon the nature of the soil and the amount of moisture present. Our investigations of subgrade materials throughout the country show us very conclusively that soils vary widely in their supporting properties, particularly at times when they contain large amounts of water, and this very difference in the supporting properties of different subgrade materials makes the question of foundation a most important one.

Effect of Water on Subgrade

Very plastic soils become exceedingly soft when they are saturated and the more porous, coarse-grained types, bordering on the sand or sand-gravel mixtures, are practically unaffected by moisture. There is a wide range of soil types and a wide range of supporting values between these extreme limits. Special problems are encountered in different sections of the country due to the unusual behavior of the subgrade under the action of water. Thus certain soils have the property of enormous expansion upon the absorption of water and corresponding shrinkage when they dry out. Such a condition, of course, results in non-uniform support for the pavements and is to be encountered especially in the outlying rather than in the built-up sections of the city, because the outlying sections offer more opportunity for these wide ranges of moisture conditions to exist.

While discussing the question of the subgrade, the formation of ice in the saturated subgrade cannot be neglected. We are all familiar with the heaving of pavements due to this action. The presence of cracks is thus not only possible but a very frequent occurrence before traffic is turned on the pavement, and in many cases the process of destruction begins through the action of forces produced through the movement of the subgrade alone. As stated, however, most of these problems concerning the subgrade have to do with outlying districts rather than with the pavements in the center of a well built-up city.

Suppose the pavement slab is to be laid on the average subgrade in which no provision has been made for drainage. Such a slab is subjected to the action of natural

forces. We are all familiar with the expanding action due to rise in temperature and due to increase in moisture content with the tendency toward the production of pavement buckling. There are, of course, well developed and efficient methods to take care of these expansive forces. The matter of shrinkage of the pavement due to the fall of temperature and of drying out cannot be forgotten, for this is productive of cracking in concrete bases and concrete pavements before traffic is turned on the pavement. It is very natural that cracks should form under conditions of shrinkage when we consider the tremendous force of friction developed between the subgrade and the concrete and

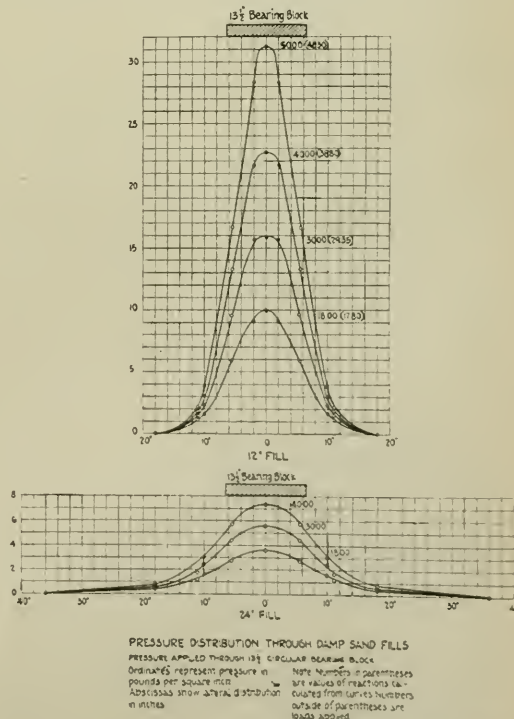


FIG. 1—PRESSURE DISTRIBUTION THROUGH DAMP SAND FILLS.

when we consider also the low tensile resistance of concrete occurring in the early stages of hardening. The cracking of concrete base is of some importance in connection with asphaltic pavements, since often times the base cracks ex-

information which should lead to methods for the elimination of waves in asphalt pavements.

Pavement Structurally Considered

Let us consider what sort of structure a pavement is and what kind of forces it must resist. In the first place, the pavement is a slab which may or may not have the ability to resist bending. It is laid on a more or less yielding material which at various seasons of the year has different conditions of moisture and which varies greatly in its characteristics throughout the country. The loads on top of the slab are sometimes at rest but generally in rapid motion. The surface of the slab is rarely extremely smooth, and in consequence the loads moving over this comparatively rough surface are applied not as static loads but with considerable impact. Suppose the pavement slab is of the yielding type, incapable of resisting bending, such as the macadam, bituminous macadam or concrete streets common in the suburbs and outlying districts of the city. When heavy loads are placed on the surface of such a pavement, the concentrated pressures at the surface are transmitted down through the pavement to the underlying subgrade. The thicker the pavement the greater will be the area distribution of the pressures and the smaller will be the pressure per square inch under load. It is a very common error to assume that the pressure intensity is uniform and is distributed over a certain area of support, which area is defined by lines sloping 45 degrees from the point of application of the load. Such an assumption is far from the truth for the pressure intensity is highest directly under the load and spreads out to nothing at some distance from the load. The curves in Fig. 1 illustrate this point very nicely. They show the pressure distribution at different depths of a sand fill when a concentrated load was placed on the top of it.

Although we have taken pressure measurements with broken stone bases, we are not ready to publish the results, but the curves will be somewhat similar to those shown. Suppose the highest intensity of pressure produced on the subgrade directly under the pavement exceeds the bearing value of the subgrade material, and let it be assumed that the pavement slab has no resistance to bending. It is very natural that under such conditions there will be local deformation of the slab under the load due to the yielding of the subgrade. If, on the other hand, the supporting value of the subgrade exceeds the highest intensity of pressure produced by the heavy concentrated load, there will not be excessive yielding and the pavement will not be deformed.

Pressure Reaction

Let us consider the mechanics of the pavement slab which is perhaps of more common occurrence in city paving, namely, the slab of the rigid type in which there is a concrete base supporting a wearing surface of asphalt, granite block or vitrified brick. Some few years ago we first made an effort to find out something of the pressure reaction under a concrete road when supporting a heavy concentrated load. We buried a number of so-called soil pressure cells under a concrete slab directly in contact with the subgrade and a heavy motor truck was used to apply the load on the slab and the distributions of the subgrade pressures under the slab were obtained, with this heavy concentrated wheel load on the surface. The curves shown in Fig. 2 are typical of the distribution of pressure to be expected under a concrete slab. It will be understood that if we are to arrive at a rational design theory we must know something of the upward subgrade reactions just as we must know their magnitude in the design of any other structure. A number of pressure readings were taken under the slab over a period of several months, both with and without traffic, and the surprising feature of these measurements was the fact that they showed such great variations from time to time, indicating very strongly that at times the slab was being supported in certain spots and at times in others. The indications have since been borne out by other measurements, so that we know that a rigid slab

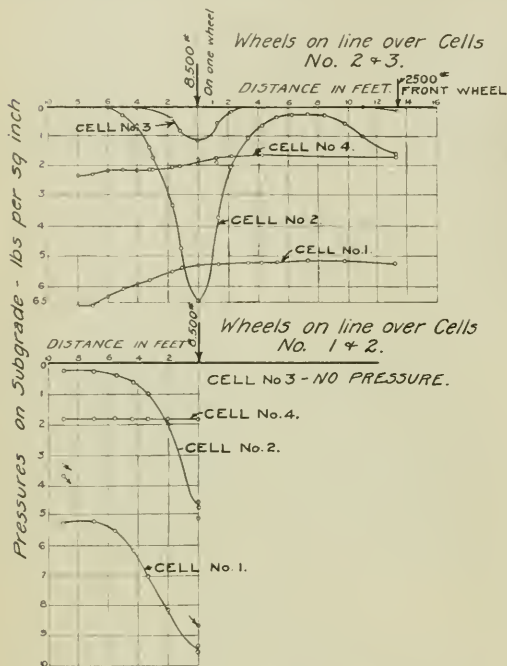


FIGURE 2.—PRESSURES UNDER CONCRETE SLAB

tend through the wearing surface. We all recognize, of course, that these natural forces of expansion, contraction and heaving, due to frost action in the subgrade, are always likely to occur but the main problem with which we are concerned in connection with the design of pavements is the adequacy of the pavement for supporting the traffic to which it is subjected. We do not have to think back over a long period of time to the time when there were no extremely heavy motor trucks and when the speed of heavily loaded vehicles was comparatively a walking pace. Pavements today, however, as a matter of every day occurrence, have to carry extremely heavy loads and this is the most important factor in the problem of proper pavement design.

Reliance on Research

There are still many problems to be solved in connection with the economic design of pavements and many problems in connection with the structural design to withstand traffic. We are continually attempting to get more and more light on these various problems by research methods. One investigation which we are conducting with the Asphalt Association involves the question of the causes of shoving of sheet asphalt pavements. We are doing this with the hope of being able to find a means for the elimination of this undesirable feature of sheet asphalt. We are also studying questions of the proper characteristics of bituminous materials, the proper mixtures of bituminous concrete, and the construction of bituminous macadam. These tests will be conducted on a large scale through the use of a circular track over which ordinary traffic will be run. Through careful observations of the test sections under traffic and the co-ordination of these sections with the laboratory tests of materials used, we hope to get some

certainly does not receive uniform subgrade support, and at times it bridges over areas offering no support whatever.

Slab Stresses

A little thought will show us that we may assume a number of conditions of subgrade support which are very common as applied to pavements. For instance, these conditions may be listed in the following cases:

Case 1. That in which the slab is uniformly supported on the subgrade and is acted upon by the concentrated loads of traffic producing a typical curve of pressure distribution as already described.

Case 2. A slab spanning a hollow spot in the subgrade receiving a rim of support, a heavy load acting upon the center of the slab over a hollow spot.

Case 3. A slab heaved by frost action at the sides with little support at the center, two heavy trucks passing one another.

Case 4. A slab supported at the center, two trucks passing one another, tending to break the slab by tension at the top.

Case 5. A heavy load at one corner of the slab tending to break off that corner.

The accompanying plate No. 3 gives approximate formulas for the maximum tensile stress that might be expected in a concrete slab when subjected to these different conditions. No attempt will be made to go into the theory from which these formulas were derived, as this has been treated elsewhere. ("Thickness of Concrete Slabs, by A. T. Goldbeck, Public Roads, April, 1919.")

The analyses of these formulas will show that under the conditions assumed with two trucks passing one another the slab will have to be exceedingly thick to carry the loads without longitudinal cracking. If it were necessary for our roads to withstand static loads alone, our design problems would be comparatively simple, but unfortunately the forces exerted on the road surfaces are considerably higher than mere static loads.

Impact Effects

Our tests on the measurement of impact on roads have already been described before the Philadelphia Engineers' Club and have been printed in their journal. I wish, however, to call attention again briefly to some of the results. We measure the impact by an approximate scheme, making use of the deformation under impact of a copper cylinder in comparison with a like deformation of a similar copper cylinder under a static load in order to express the magnitude of the impact. It will be recalled that we used a number of different weights of motor trucks running at different speeds, equipped with different kinds of tires and caused the trucks to produce impacts under different conditions, varying the height of fall from zero up to 4 in. Speaking approximately, these impact tests on a pavement of ordinary roughness showed that the maximum pressure produced under impact might be four or five times the wheel pressure when the truck is at rest. The amount of the impact was dependent very largely on the kind of tires, and to some extent on the design of the vehicle. Apparently, the amount of cushioning supplied by the tire governs the amount of impact; the better the cushioning properties, the more nearly the impact approaches a static load. With impact effects under moving wheels equaling four or five times the static load of the vehicle, it is very apparent that such impacts are apt to have a very serious effect on the pavement surface, as well as on the entire pavement structure.

We have just completed a large series of tests on pavement slabs of different types subjected to impact and to my mind these tests apply directly to the conditions of city paving. The amount of impact having been determined, the question naturally arises in our minds as to what effect this amount of impact would have on different types of pavements. In order to determine this we laid down a number of slabs of concrete of different design and also a number of brick slabs on concrete as well as broken stone bases. We attempted to have half of these slabs on a very wet subgrade and half on a very dry subgrade in order to show us the effect of different subgrade support. Then we

rigged up an impact machine that consisted of a heavy weight of 1,800 lb., shod with a piece of 12-in. truck tire. Upon this weight we mounted a 5-ton truck spring and the spring supported a box in which was placed a weight of

Notation

- S = unit tensile stress
- P = concentrated load
- d = thickness of slab in inches
- w = weight of concrete per square inch with thickness d
- S = width of slab in feet

Case I—Slab Supported by Subgrade—Cone of Support

$$S = \left[\frac{3P}{2\pi d^2} - \frac{2wR^2}{d^2} \right] \frac{6}{10}$$

Case II—Slab Spanning a Circular Soft Spot in Subgrade

$$S = \left[\frac{3P}{\pi d^2} - \frac{2wR^2}{d^2} \right] \frac{6}{10}$$

Case III—Slab Supported at Sides of Road—Two Trucks Passing

$$S = 0.6 \frac{P}{d^2} \left(\frac{2-3}{1.5-3} \right) + 9.4 \frac{S^2}{d^2}$$

Case IV—Slab Supported at Center—Two Trucks Passing

$$S = 0.6 \frac{P}{d^2} \left(\frac{2-6}{3} \right) + 9.4 \frac{S^2}{d^2}$$

Case V—Load at Corner of Slab

$$S = \frac{3P}{d^2}$$

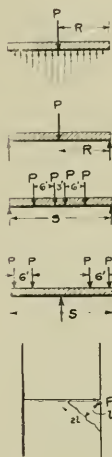


FIGURE 3—FORMULA FOR STRESS IN ROAD SLABS UNDER LOAD

6,000 lb. This entire weight was then raised and allowed to fall repeatedly, beginning first at a very small height of fall and after every 500 blows this height of fall was increased slightly.

Pavement Thicknesses

Generally, it might be stated as the result of these tests that the resistance shown by 1:1½:3 concrete, 7 ft. square slabs is very consistent and increases uniformly with the increase in thickness. In the slab 6 in. or more in thickness only primary cracks formed, while the 4-in. slabs were punched out at the center. From this it would seem that plain concrete surfaces 4 in. in thickness are entirely inadequate for heavy motor truck traffic. Monolithic brick slabs in most cases showed less resistance than 1:1½:3 concrete slabs of the same depth. Failure seemed to result from shearing of the brick top from the concrete base before full resistance of the monolith was developed. The indications are that under impact, shearing stresses are much more severe than under static loads. Grouted brick surfaces compared favorably with 1:1½:3 slabs of the same thickness, while grouted brick beams showed resistance in excess of those offered by 1:1½:3 concrete in static loads. The slab strength of the concrete base was very little increased by bituminous filled brick surfaces.

The indications are that the resistance of the specimens increased with increased bearing value of the subgrade. The relation between the strength of 1:1½:3 and 1:3:6 concrete specimens, as shown both by static beam tests and impact slab tests, differs from that shown by the compressive tests on cylinders and cubes. Although the compressive strength of 1:3:6 concrete was 50% of that of the 1:1½:3 concrete, the difference between the beam and slab strength of these two mixes does not exceed 20%. As a result of the analyses of these experiments, the curve shown in Fig. 4 was prepared indicating the relation between the thickness of a 1:1½:3 concrete slab in inches and the resistance which such a slab 7 ft. square offers to

impact when laid on a subgrade such as existed during the tests. Although such a curve does not lead us with certainty to the rational design of concrete bases of pavements, it goes far in aiding our judgment as to what the proper

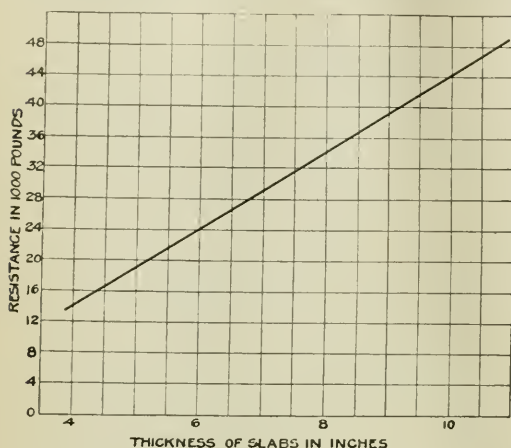


FIG. 4—RESISTANCE OF 1 1/2 : 3 CONCRETE SLABS TO IMPACT

thickness of the pavement should be to withstand certain kinds of traffic. Our impact tests have already shown us what impacts to expect. The present curve shows us what slabs are capable of resisting various amounts of impact. Combining this information with what we know of subgrade conditions, we are in a much better position to say when our pavement thicknesses are adequate.

Practical Considerations

In considering the design of such pavements, particularly pavements in well built-up portions of the city, I believe that in general we can safely assume that the subgrade will almost never become as wet and soft as it has a chance to become in country highways where the surrounding country can become thoroughly water-soaked. I need not call your attention to the fact that such pavements are thoroughly protected from moisture from above. Moreover, any water which through underground sources might have a tendency to accumulate, is conducted away by the numerous sewer pipes under the pavement. Then too, in congested portions of the city, the motor truck traffic necessarily moves quite slowly, so that the impact is much reduced below what it might be on open stretches of concrete. So that, no doubt, many pavements which have proven inadequate for country highways when subjected to heavy motor truck traffic, would give splendid service in congested portions of cities. It is true that no matter where an opening is made in a city pavement it will be found that the subgrade is moist, but recent experiments made by us seem to show that when soils have moisture in them which does not exceed the so-called "moisture equivalent" their bearing value is quite high and when the moisture exceeds the "moisture equivalent" the bearing value is greatly reduced, although this has not been established as a rule of universal application to all soils. I am of the opinion that the subgrade material under our city pavements practically never has a percentage of moisture exceeding the so-called "moisture equivalent." (Tests for Soils with Relation to their Use in the Subgrade of Highways," by Messrs. Jackson and A. T. Goldbeck, A.S.T.M. Proceedings for 1921).

In the more open sections of the outlying districts of the city there is more danger of the subgrade becoming soft and it is here that we might expect trouble from the combinations of heavy loads and soft subgrades, for the corres-

ponding conditions of traffic, I would feel inclined to design heavier sections for the outlying districts than for the well built-up sections of the city. In residential sections, failures in pavements are often noted, notwithstanding the comparatively light traffic. This is particularly so in conditions where there are high terraces on one or both sides of the street and it is very probable that such a condition of topography is productive of high moisture content in the subgrade under the street. Under such conditions it will be well to keep in mind that here failure is likely to occur and here the design should be made heavier for the conditions of traffic to be met than elsewhere where the topographic conditions are more favorable toward natural drainage, or special drainage precautions should be used. For the conditions at Arlington we were unable to produce failure in any of our 10-ft. slabs, but we did succeed in breaking the remaining slabs.

I hesitate to attempt, on the basis of my present knowledge, to formulate any definite rules of procedure in selecting the proper thickness of pavement for various conditions. I think that from what I have said thus far, and especially from a detailed study of the several papers which have been written in connection with our studies at the Bureau of Public Roads, you will not be lead far astray in letting these results aid your judgment, especially if you are careful to keep in mind the probable condition of subgrade support and the probable traffic and its speed.—From a paper read recently before the Conference on City Paving, at Philadelphia.

ELECTRICAL OPERATION OF SUCTION DREDGER

A 20-in. suction dredger in use on the Sumas River in Washington was recently converted from steam to electric operation by the Marsh Construction Company. As now arranged the dredger has a total connected load of 1,322.5 h.p., with motors ranging up to 1,000 h.p. Current is used at both 2,300 and 440 volts, a cable and reel maintaining connection with the shore as the vessel moves forward.

Power is taken from the 34,000-volts transmission line that parallels the line of operation of the dredger, leads running from it to a bank of three 500-k.v.a. transformers mounted on a scow moored to the bank of the river. This scow and the dredger are connected by a 1,000 ft. length of submarine cable carried by a reel mounted on a small scow lashed to the dredger. This cable is paid out automatically as the dredger moves ahead until all the cable has been reeled out. The transformer scow is then cast adrift and moved ahead, the slack in the submarine cable is coiled up on the reel, and a new connection is made between the transmission line and the transformer bank in its new position.

The two largest power units on the dredger are the 1,000 h.p. motor that drives the main pump at the rate of 300 r.p.m., and the 150 h.p. motor that operates the cutter through a set of reduction gears. After the dredger had been in operation for a few weeks material was being handled at the rate of approximately 600 cu. yd. an hour at a cost for power of from 1 to 1 1/4 cent per yard. Under normal operating conditions the dredger requires from 900 to 1,000 kw.

A conference of Elgin County road foremen will be held in the Court House, St. Thomas, about March 1. Frank Pineo, County road superintendent will be in the chair. A similar conference will be held in London on February 23 under the direction of Engineer Talbot, superintendent of the Middlesex county roads.

The headquarters of the Alberta Architectural Association will be removed from Edmonton to Calgary for a period of two years, and the next annual meeting of the association will be held in Calgary next year. At a meeting held in Edmonton on Feb. 1, Jack Burrell was selected president and R. A. Millar, secretary-treasurer.

THE ORGANIZATION OF METROPOLITAN DISTRICTS

Report of Sub-Committee on Sewage Submitted to American Society of Municipal Improvements—Powers of Boards Controlling Districts

By Langdon Pearse

Sanitary Engineer, Sanitary District of Chicago

WITH increased attention to water supply and, in particular, the development of pure water supply and clean waterways, considerable activity has resulted in the formation of various commissions, boards of districts, looking toward the provision of facilities for two or more municipalities acting together. These efforts have come about through the legal difficulty of co-operating without some method of joining responsibilities by organization, and with the knowledge that better development can be had through utilities, such as a water or sewer system, planned to serve a drainage area or district rather than individual towns by political boundaries. This tendency was early recognized in England through the formation of river boards, such as Birmingham, Tame and Rea Drainage Board, under whose control is the removal and disposal of sewage of Birmingham and surrounding territory. Such boards in England have been jointly organized under various parliamentary acts for the cleaning of streams to prevent nuisance. In the United States the tendency was originally toward the formation of commissions organized and empowered by the state to carry out specific work. Among the earlier commissions were the Metropolitan Sewerage Board in Massachusetts, serving Boston and the metropolitan area around, and the Metropolitan Water Board. These two were later consolidated into one board after the major portion of the work had been accomplished. The Water and Sewerage Board has developed largely into an operating organization. On the other hand, in the West, in Illinois, the formation of sanitary districts received an early start with the enabling act in 1889 forming the Sanitary District of Chicago, a separate municipal corporation with broader powers than those of the Massachusetts Commission; the former being a separate municipality overlying other municipalities, but with a particular purpose and indefinite life. Further, broader bonding and taxing powers were given than in the East. Other enabling acts have been passed in Illinois and in Indiana. In New Jersey, the formation of the Passaic Valley Sewerage Commission and such joint projects, as the Plainfield, North Plainfield and Dunellen Sewerage District, have added to the list.

In the desire to obtain municipal ownership of waterworks in the State of Maine, the water district idea was developed largely through the efforts of Harvey B. Eaton, an attorney, who has summarized the history and enabling acts very completely in a paper entitled "Maine Water Districts and Appraisals" published by the New England Works Association.

The Maine water districts resembled the Sanitary District of Chicago, in that they had bonding and taxing powers and were overlying municipalities organized for a specific purpose, in the water districts, that of serving water. A number of districts have been organized in Maine. Elsewhere might be mentioned the Greater Winnipeg Water District and the Metropolitan Water Board of London (England). There are also a number of private water companies supplying groups of towns.

In a report upon the metropolitan water and sewerage systems made to the Essex Border Utilities Commission, Windsor, Ont., (1917). Morris Knowles has covered very broadly the Metropolitan district idea, pointing out the need of community co-operation, the methods of securing unity action by (1) annexation, (2) extension of municipal jurisdiction, (3) contracts between municipalities, (4) county administration, (5) private enterprise, (6) metropolitan districts. Various examples are discussed, and the difficulties. The methods in vogue of payment of costs are also discussed, chronologically.

Our Committee has tried to summarize in convenient form most of the existing organizations. It is hoped that discussion may be promoted, and possibly further examples cited to make the report more complete.

No mention will be made in this report of the commissions organized to make engineering reports or metropolitan projects, such as the Metropolitan Sewerage Commission (N.Y. City), Commission on Additional Water Supply (N.Y. Hering-Burr-Freeman), Charles River Dam Commission (Boston) and others. Their field has been a useful one, in most cases paving the way for construction and leading to broader acts for the construction organization.

Schemes Tried for Organizing Metropolitan Areas

In general, it is the purpose of this report to cover largely the districts formed for sewerage or drainage of metropolitan areas, and not the drainage of farm areas. For the purposes of constructing the sewerage system of large metropolitan areas, and the disposal of sewage therefrom with the increase of population, and the need of more complete methods, various schemes have been tried as outlined. These may be summarized according to the degree of authority given, and appear to fall under four general groups.

1. Commissions or boards formed by city councils for the specific purpose of building intercepting sewers largely and practically within the confines of one municipality. These hardly come within the definition of the metropolitan districts serving two or more municipalities, but should be mentioned because of the organization of such commissions as the Fitchburg Sewer Commission, and the Syracuse Intercepting Sewerage Board, and others.

2. Boards or commissions appointed by elective officers of cities, county or state, given resources, either limited by specific act or by action of the municipal or Federal bodies governing the municipalities composing the district. Under this classification might be placed such boards as the Metropolitan Water and Sewerage Board, the Passaic Valley Sewerage Commission, the Commission of the District of Columbia and others.

3. The formation of sanitary districts which are complete municipalities in themselves, with powers of taxation, with bond issues dependent upon referendum, and with officials appointed by county or state officers. Under this classification come the smaller sanitary districts in Illinois, such as those organized at Decatur, Bloomington, the North Shore Sanitary District, and Downers Grove.

4. Sanitary districts organized as municipalities with complete taxing and bonding powers, without referendum on bonds, with governing officials elected by direct vote of the people residing within the limits of the district. Under this classification comes the Sanitary District of Chicago.

Practically all the districts mentioned and discussed in this report are those lying within the boundaries of one state. The Committee has thought it desirable to call to the attention of those interested the need of some form of organization which will insure co-operation between districts lying in two or more states. With the growth of pollution in streams, and the difficulties in obtaining suitable water supplies such metropolitan difficulties may occur on stream watersheds, both from the water and sewerage standpoint, involving two or more states, as in the case of the Ohio River, for instance, involving Ohio, Kentucky, West Virginia, Pennsylvania and in Missouri territory in the vicinity of Kansas City where territory lying in Missouri has to be considered. Such relations under the governmental organization of the United States would appear to require a federal Act covering the creation of river or drainage boards, with powers extending over several states, to co-ordinate effort and use common policies in matters relating to use of streams for sewage disposal and the taking of water supply therefrom. This would appear to be the next development in a chain of acts which has been gradually formed through the last forty years.

To finance the necessary works, money must be raised. This is usually done by issuing bonds, or by special assess-

ment. Occasionally part of the general taxes is also designated. Operating and maintenance charges, as well as the payments of interest and sinking fund to retire bonds, when issued, are generally met by taxation, or by special assessments and also by rates based upon service.

Where the power to issue bonds is given the amount to be issued is usually fixed, sometimes by definite figures as at Fitchburg and Syracuse, but generally in terms of percent of the valuation of assessed property. In many states this is 5 per cent, an amount fixed by the state constitution. In the Indiana acts, the per cent is fixed at 0.5 of 1 per cent for Indianapolis, and 2 per cent in the general act (1913). In Illinois, the Sanitary District of Chicago has a 3 per cent limit, whereas under the other Illinois acts, a 5 per cent limit is set. The maximum rate of interest is also sometimes stated. The maximum rate of interest on bonds is often limited to 5 per cent as in Indiana, although in the case of Indianapolis a 4½ percent limit was fixed. The retirement of bonds is also provided for, 20 year annual installments being common, notably in Illinois and Indiana. In the Essex Border Utilities Act the limit was set at 30 years, whereas at Indianapolis 50 years was allowed.

In the older districts bonds may be issued without referendum for corporate purposes. In the districts formed more recently, many acts require a referendum on the bonds, as a whole. Where the act specifically limits the amount in dollars, as a rule the act is the result of public agitation demanding particular relief.

In the case of the Illinois and Indiana districts, special assessment has not been used to meet construction costs in Metropolitan organizations. In the Passaic Valley, however, the cost of construction was assessed or apportioned among the various constituent municipalities roughly in proportion to the service rendered. In the Vancouver sewage act 30% of the construction cost is to be assessed upon the municipalities in proportion to their land valuations, and the remaining 70 per cent in proportion to the valuation upon lands benefited. But in determining the division of operating costs, assessment is frequently made against the individual municipalities in the district, which in turn is distributed by taxes or service charges as in the Boston Metropolitan District, Passaic Valley and Miami Conservancy. In Illinois and Indiana, tax levies are made through the usual machinery, to raise the moneys to pay interest, operating and maintenance expense, and provide a sinking fund to retire bonds.

The maximum rate of taxation is usually fixed. There would, however, seem to be a legitimate need for a minimum rate to provide necessary funds for running expenses.

In Indiana, for Indianapolis, a levy of two cents on the \$100.00 was allowed, plus a levy for sinking fund and interest. The general Indiana Act provides for 0.25 of 1 per cent.

In Illinois, the Sanitary District has a taxing power of 2/3 of 1 per cent of the assessed valuation. Owing to the scaling of the amount by the county clerk, a recent amendment has placed a minimum rate of ½ mills on the dollar. The general Illinois acts provide in one case for a rate not to exceed 1/3 of 1 per cent, and in the other for half of 1 per cent, although this latter may be doubled by a referendum vote.

In the Miami Conservancy District a levy of 0.3 mills on the dollar is provided for preliminary expenses.

The size of the governing board varies widely from a minimum of three (Illinois general, 1917) to a maximum of 13 (New Orleans) in the U. S. and 17 (Essex Border) in Canada. Some acts provide for service without pay, others provide pay as high as \$7,500 per year.

The limits set on the powers of the board vary. Some acts are very explicit on the terms of advertising contracts, etc., others are not. Ten days is a common limit, but some prescribe thirty-one days. The limit of expenditure without advertising is occasionally fixed, \$500.00 being a common figure.

In general, the acts appear to have been effective in providing machinery for necessary work. Occasionally, where a referendum is required, the project has failed by

lack of votes to authorize bonds (Bloomington and Normal) or has been delayed by failure to seek authorization of bonds. The limits set by per cents of valuation in some cases have proved inadequate, and in future acts should be chosen with greater care, to provide necessary funds, both by taxation and by bond issue.

Greater Vancouver Sewerage District

The greater Vancouver Sewerage District was organized in 1913 for the construction and maintenance of the necessary intercepting sewer and sewage disposal plants for taking care of the Urban district around the city of Vancouver.

New Orleans Water and Sewerage Board

The New Orleans Water and Sewerage Board was organized under an Act of the Legislature in 1889. The Act was made operative by vote of the registered tax payers of the city of New Orleans. The Board is composed of thirteen members, including ex-officio the Mayor, commissioners of public finance, public utilities, public property, president and members of the Board of Liquidation, and seven members representing the seven municipal districts, the latter appointed by the mayor. These members hold office twelve years each without pay. There are standing committees known as the executive, finance, sewerage and water, and drainage. The organization is operated under a general superintendent, who is also a chief engineer, with six departments.

Syracuse Intercepting Sewer Board

The Syracuse Intercepting Sewer Board is organized under an Act providing for the appointment of three intercepting sewer commissioners by the mayor and hold office for five years. The Enabling Act authorizes and empowers the Board to construct certain intercepting and storm water sewers, and also regulate and improve particular water courses throughout the city. From time to time the Act has been amended to provide for sewage disposal works, additional storm water sewers and flood prevention. As amended, the Act provides that bonds may be issued up to the amount of \$3,200,000 to be sold by the city upon resolution passed by the Board requesting funds in definite amount.

Fitchburg Sewage Disposal Commission

Under Chapter 461 of the Acts of 1910, State of Massachusetts, the Fitchburg Sewage Disposal Commission was organized by the appointment of three commissioners by the mayor with power to construct a system of sewage disposal. Under Chapter 354 of the Acts of 1901 the amount of bonds issuable was limited to \$500,000, but this limit was extended by a subsequent Act providing for an additional \$500,000. Under this Commission the chief engineer was also the city engineer.

Metropolitan District Commission

Under Chapter 350 of the General Acts of 1919, Massachusetts, provision was made for the formation of the Metropolitan District Commission, whereby the Metropolitan Park Commission and the Metropolitan Water and Sewerage Board were consolidated. The Metropolitan District Commission is to consist of one commissioner and four associate commissioners appointed by the Governor with the advice and consent of the State Council. The commissioner is to be appointed for a term of five years, and the associate commissioners will eventually be appointed for the term of five years, although at first for one each for 1, 2 and 4 years. The commissioner is made the executive and administrative head. The Commission may be organized into divisions as heretofore, with the usual clerical, police and engineering force.

Washington Suburban District

Provision was made by Chapter 122, Acts of 1918, Maryland, for the organization of a Sanitary Commission in the Counties of Montgomery and Prince George for the construction of sewerage works. The administration pro-

vides for three members, one to be appointed by the Governor, and one by each Board of County Commissioners. Funds are to be derived by joint taxes for trunk lines and by special assessment for laterals.

Indianapolis Sewerage District

The Act under which the Sanitary District of Indianapolis was organized is Chap. 157 of the Acts of 1917, of the State of Indiana. This Act is written for cities of the first class, and creates, in addition to existing executive departments, the Department of Public Sanitation, under the control of a Board of three sanitary commissioners; two to be appointed by the mayor and the third to be the city engineer ex-officio. One of the two appointees should be an engineer, nominated by the State Board of Health of Indiana. The engineer and the nominee of the State Board of Health nominate the third man for approval of the mayor. The commissioners serve for four years. The powers given to the commission are broad and cover and control the construction of sewage disposal works, intercepting sewers, maintenance of operation, and also the handling of garbage, from the standpoint of disposal, but not collection. The Board has the power of condemnation within five miles of the city and can enter for surveying.

Sanitary Districts in Indiana

Chap. 307 of the General Laws of Indiana, 1913, is an Act providing for the incorporation of Sanitary Districts. The original Act provided that two or more incorporated municipalities in any one county might form a Sanitary District, upon petition of 500 legal voters, and upon the majority vote passed by each municipality in an election held for the purpose. Five trustees are to be appointed by the Governor of the State. The Act provides for the construction of works, including sewers, sewage treatment plants and pumping stations, and for the issuing of bonds in an amount not to exceed 2 per cent. of the valuation, together with the levying of taxes to pay the interest and principal. The bonds shall not run more than 20 years.

The District of Columbia

The District of Columbia, which is the seat of government of the United States, as defined by the Constitution, comprises a territory of seventy square miles, ceded by the State of Maryland to the United States and located at the head of tide water on the Potomac river. The population, July 1, 1921, was 460,000.

Under powers conferred by the Constitution, the Federal Congress exercises exclusive and almost unlimited powers over the population within this territory. After a varied experiment for three quarters of a century with local self government, in 1878, Congress took away all such rights and placed the District under a commission form of government, with a board of three commissioners appointed by the President of the United States each for a term of three years with no limit as to reappointment. The Commissioners of the District of Columbia, constitute a governing board that is purely administrative. Exclusive of their functions as a Public Utility Commission, they have no broad, governing powers, and what may appear to have considerable scope, are in reality so restricted by the acts or the action of Congress as to possess only the barren powers of recommendation. In this connection it is to be noted that both the Senate and the House of Representatives maintain a standing "Committee on the District of Columbia," and in addition the Appropriations Committee of the House has a permanent sub-Committee which in effect is authoritative in all fiscal matters.

Not all the amounts thus appropriated in great detail as to items, are expended under the direction of the Commissioners of the District of Columbia, but come under the exclusive control of the Department of the Federal Government, such as War, Justice, etc.

As Congress fixes just what streets are to be paved and what school houses built and the amount allowed for each individual item, the expenditure of the appropriations may be considered purely administrative. The Commis-

sioners have no bonding powers, and no taxing powers except as noted, and no referendum is permitted the population on any subject. The Water supply is under the War Department except only the municipal distribution mains and house meters.

New Jersey

"The Joint Meeting of the Inhabitants of the City of Plainfield, the Borough of North Plainfield and the Borough of Plainfield" is the corporate title of the joint municipality which handles the sewage and treats it at Green Brook Park.

The first step was the passage of a law by the State legislature in 1910 permitting two or more municipalities to join in a contract for the collection and disposal of sewage and authorizing such joint municipalities to acquire land outside of their own boundaries for sewage disposal sites and defining procedure in claims for damages. The second step was the execution of a contract among the three municipalities providing for proportioning costs of construction and operation. The division of the cost of construction was somewhat arbitrarily determined for the reason that the above-mentioned law states that any municipality having paid not less than 25 per cent of the initial cost shall have a veto power on all matters of expenditure. North Plainfield chose to pay this proportion in order to secure such veto power. The division of costs agreed upon in per cents was Plainfield 68, North Plainfield 25, Dunellen 7. All new construction work and enlargements are paid for in this proportion, but the provision is made that enlargements made necessary by the abnormal demands of any one municipality over its proportionate share shall be paid for accordingly by such municipality.

Money for construction costs was provided by bond issues of the individual municipalities, the money being provided from time to time in accordance with the Engineers' progress estimates. Construction bills were approved by the Engineer, passed upon by the "Joint Meeting" (the entire council of each municipality in joint session), then passed upon by each council independently the money appropriated by each council separately and paid into the hands of the Treasurer, who then paid the bills by checks signed by himself, the president and the secretary of the Joint Meeting.

Passaic Valley Sewerage District

Passaic Valley Sewerage Commissioners is a corporate body existing under the laws of the State of New Jersey for dual purposes; first, to act as the agent of two or more municipalities, lying in whole or in part within the Passaic Valley Sewerage District, in the construction and operation of system of metropolitan sewerage works for the relief of the polluted condition of the Passaic River; and second, to act, as an arm of the State, to prevent the pollution of the said river after a date fixed by the Legislature.

There are five commissioners, one being appointed each year, by the Governor, to serve a term of five years. The Passaic Valley Sewerage Commissioners have no taxing power. Monies for the construction of sewerage works are made available through definite appropriations authorized, from time to time, by the contracting municipalities, each municipality paying a proportionate share based on its net taxable valuations. The cost of operation and maintenance is to be apportioned, annually, among the contracting municipalities, in direct ratio with their respective sewage flows.

Miami Conservancy District

The Miami Conservancy District is organized under the Conservancy Law of Ohio, passed February 5, 1914. This law was prepared to provide the necessary machinery for works to prevent flood, to protect cities, villages, farms and highways from inundation and to authorize the organization of drainage and conservation districts. Briefly the conservancy district is established by petition of the property owners to the Court of Common Pleas in any country. The Court appoints a board

of three directors and also three appraisers. The Miami District includes part of ten counties. The appraisers appointed by the Court have no executive functions, their duty being to determine benefits and damages. The Board of Trustees is the governing body of the municipal corporation with discretion to organize the administrative offices as they deem best. The organization of the Miami District is as follows: The Secretary of the District makes the immediate routine and administrative contact with the Board of Directors and has general supervision of the offices. Under the Secretary are the three departments. The Department of Taxation is occupied with the clerical work of spreading the assessment on the tax books. The Farm Department is engaged in disposing of the surplus lands which were secured in our right of way condemnations. Otherwise the entire work of the District is in the hands of the Department of Engineering and Construction.

The Chief Engineer is in direct charge of engineering and construction for the District. He employs men, makes contracts, which in important cases are presented to the Board, and is in every respect responsible for engineering and construction. The Department of Engineering and Construction is separated into two divisions. The Engineering Division exercises the usual functions of the engineer, while the Construction Division exercises the usual functions of the contractor. These divisions are manned as though the job were let on contract and the responsibility is distributed on that basis. However, there is very close co-operation between the Engineering and Construction Departments since both are under the direction of the Chief Engineer.

Essex Border Utilities Commission

This act as amended is No. 15 of the year 1921, in the Province of Ontario. The Essex Border Utilities Commission is an interesting development, providing the necessary machinery for the handling, not only of sewers and sewage treatment, but also water works, board of health, hospitals, parks and town planning, for a number of communities. As at present constituted the Commission consists of the mayors of five towns, two reeves and ten members elected every three years. Money is raised by special taxes and by the sale of debentures, the term of which shall not exceed 30 years. The cost of construction, maintenance and operation is divided in proportion to the benefit, as determined by the engineer. Questions are submitted to qualified voters for referendum and must be approved by at least three of the municipalities.

The Sanitary District of Chicago

Operative under the Act of May 29, 1889. The original Act of May 29, 1889, has been amended in various years, both to extend the powers of the District and to cure various defects found, as well as to provide for annexation of additional areas. While originally drawn as a General Act, it has been adopted alone by the Sanitary District of Chicago. Powers are granted by the charter to build channels, drains and docks, dispose of water power, and by the most recent amendment specific power to construct intercepting sewers, pumping stations and sewage treatment works. The District at present comprises some 45 municipalities, including the city of Chicago. For the purpose of administration, a Board of nine members is provided, three of whom are elected every two years, and one of whom is chosen by the Board to act as presiding officer. The funds for the work are provided by the issuing of bonds, in amounts not to exceed 3% of the assessed valuation. For operating expenses, payment of interest and the like, provision is made for a taxing power not to exceed 2/3 of 1% of the assessed valuation. The most recent amendment provides for a minimum levy of 1.2 mills on the dollar. The area served at present is 395.51 square miles, and includes all of Chicago and 45 incorporated cities and villages.

Illinois Sanitary Districts

The difficulty of financing sewage disposal projects for the smaller cities of Illinois, ranging from 10,000 to 50,000 in population, lead to a desire for a Sanitary District Act,

which would suit their needs. The Act creating the Sanitary District of Chicago did not prove applicable. Two acts are in existence in the laws of the State, one being printed in the Laws of Illinois, creating sanitary districts, and providing for sewage disposal; the other given in Hurd's Revised Statutes, being an Act passed in 1911. The latter Act is drawn largely with reference to villages taking water from Lake Michigan. General powers are given to the Sanitary District to construct works, and further levy an annual tax for corporate expenses not to exceed 1/3 of 1% of the valuation. Before any bonds can be issued, a referendum has to be held. Under this Act, one Sanitary District has been incorporated, the North Shore Sanitary District.

Under the Act of 1917, several sanitary districts have been incorporated, including Decatur, Bloomington, Normal and Downers Grove. Broad powers are given to the Board for the purposes of constructing sewerage works and sewage treatment.

Wisconsin

The Milwaukee Sewerage Commission operates under an Act entitled "An Act relating to the Sewage Disposal Works in Cities of the First Class." This act provides that the common council of any city of the first class may vote for the establishment of a sewerage commission, and if carried by a majority, the Mayor appoints five members. The Commission covers construction of intercepting sewers and sewage treatment works. Provision was made in 1917 for approval of plans where other towns in the same county are doing similar work. This has been enlarged in 1921 to provide for a Metropolitan Sewerage Commission, consisting of 3 members appointed by the Governor, one of whom is to be a member of the city sewerage commission.

Greater Winnipeg Water District

The Greater Winnipeg Water District was originated under Province of Manitoba Acts of 1913 and provides for the organization of a municipal corporation including at first four municipalities. The Board is made up of the Mayor and Board of Control of Winnipeg; the Mayor and one member of the council of St. Boniface, and the Mayor or Reeve, as the case may be, of the minor municipalities. The Mayor of Winnipeg is chairman of the Board. The purpose of this Water District is to supply the inhabitants with pure water from a permanent source in bulk to each of the municipalities. The cost of service is to be arrived at on the basis of maintenance operation and management.

Board of Water Supply, New York City

This well-known board was authorized by Chapter 724 of the laws of 1905, New York State. For many years it has been the custom of the City of New York when it had a large public improvement to carry out, to create a special Commission for that purpose, having broader powers than possessed by any of the City departments. So the Act was passed, with the object of securing administrative authority with broad powers and not subject to the many annoyances and delays to secure successive approval of the public bodies, as in the case of the regular city departments, and also to secure reasonable permanence of office. The Act provides that a Commission to be known as the Board of Water Supply, with three members, be appointed by the Mayor, this board to determine what sources were most available, desirable and best for an additional supply of pure and wholesome water for the City of New York, and report to the governing Board of the City, the Board of Estimate and Apportionment. This Board was to approve the outlined plan of the project for a new water supply, which could be submitted in parts or as a whole and be modified later, if desirable, with the approval of the same body. It was the duty of the Board of Water Supply to prepare contracts and carry out the work without any further approval of the governing Board of the city.

At a meeting of the Ontario Association of Architects in Hamilton on Feb. 7, Major R. Lewis gave an address on "Waterproofing."

COMPARATIVE METHODS OF LIFTING SEWAGE

Relative Advantage of Three Methods of Pumping Sewage
—Efficiency of Different Types of Pumps—Maximum Heads for Lifting Sewage

By F. G. Lloyd, F.C.S.

MY excuse for dealing with this subject is that I have had some years' experience with pumping plants, and I recently obtained very interesting information when carrying out a series of tests on centrifugal pumps.

We may, I think, confine our attention to three methods:—Centrifugal and reciprocating pumps and ejectors. It should be distinctly understood that I have not arranged the headings with any idea of suggesting they are placed in order of merit. That, of course, is entirely a matter of opinion and a question to be determined by local conditions.

It may be pointed out that with centrifugal and reciprocating pumps screening is absolutely necessary, but with ejectors it can, under most circumstances, be dispensed with.

Centrifugal Pumps

This is a rotary pump, transforming the velocity of the liquid into pressure. Manufacturers' designs will vary in detail, the number of vanes may differ, and we have the open and shrouded impellers. When dealing with clear water, the shrouded type may be quite satisfactory, but sewage is a different matter altogether, and from experience of both, I unhesitatingly express my opinion in favor of the open type. There is less liability of choking and consequent friction, and on test it gives altogether better results.

I think I am correct in stating that by far the greater number of sewage works use centrifugal pumps for the reason that they are less liable to give trouble owing to the absence of valves. When placed above the sewage they require priming, but can be fixed in chambers below water level to obviate this, and if electrically driven can be started and stopped automatically by float gear.

I would like to submit for your consideration one or two points in construction that I consider important. With regard to accessibility, the inspection or hand holes should be sufficiently large to enable any foreign matter that collects in the eye of the pump to be removed without difficulty. They should be provided with a top cover in preference to one at the side to enable the wear on the impeller and side plates to be more readily gauged. The side plates should be of chilled steel and conveniently fixed for renewal and the impeller of manganese steel. In consequence of the grit contained in sewage, the ordinary cast-iron impeller very soon shows signs of wear.

I express the opinion that the speed should be kept as low as possible, and by so doing we have a larger pump and consequently greater clearance, and owing to the reduced velocity of the sewage the life of the pump is considerably longer. I am unable to say definitely, but I consider that by doubling the speed the wear is probably increased by four times. Apropos of this, I notice that the London County Council put in six new pumps about 1917, running at 260 r.p.m. We have 10-in. pumps working at 450, 620 and 720 r.p.m., and I much prefer the lower speed for general results.

In putting down a centrifugal pumping scheme, it is desirable to have units of different capacity to suit varying flows, but it is possible to throttle down when running electrically without greatly reducing the efficiency. Considered generally, these are very convenient pumps for sewage lifting.

Reciprocating Pumps

When dealing with greater heads, there is much to recommend this type of pump with special reference to the single-acting ram pattern; but here again we have to consider the large amount of foreign matter contained in sewage and frequent trouble with valves. The fullway flap valve is the only possible one to consider, and even with these a piece of wood under the hinge will prevent its closing, with consequent loss of duty, and very close observa-

tion will be necessary to detect the difference occasioned by a partly-opened valve, but it will naturally increase the cost of lifting. No priming arrangement is necessary as with centrifugal pumps, but with the gritty matter the cylinders get badly scored and the upkeep is often costly.

Ejectors

This method is well known, and is usually adopted under special circumstances where no fall is available to obviate the costly laying of deep sewers. One advantage of the system is that a district can be divided into several sections, each draining to an ejector station and lifting automatically by compressed air generated at a central station.

There are several reliable makers of this type of lift, but the principle of them is all the same. An ejector is a hollow vessel varying from 50 to 1,000 gallons' capacity, and is placed in a chamber below the invert of the sewer. They are usually designed to fill and discharge once a minute. A 100-gallon ejector would therefore discharge 144,000 gallons in twenty-four hours. This, however, could be accelerated by increasing the size of the connections and the air pressure, the latter under ordinary circumstances being approximately 0.5 lb. per sq. in. per ft. of lift. In some cases single ejectors are used, in others they work alternately in pairs.

Although, as I have stated, the usual arrangement is to discharge once a minute, this is not necessarily the case. Some twenty-five years ago a plant was installed with 500-gallon ejectors, to be capable of discharging 750 gallons per minute, so that the ejector had to fill and discharge in 40 seconds. This plant, I understand, worked successfully.

The first public authority to adopt this system was Eastbourne. A plant to lift $2\frac{1}{2}$ million gallons per day was put down in 1880. Since then several additions have been made, and the installation is one of the largest in the country.

For economical working, ejectors require careful adjustment. There are, however, few working parts. There is very little wear, and the expense for repairs and renewals is small; the mechanical action is very simple.

Relative Efficiency

When considering the question of efficiency with reference to the lifting of sewage, one has to proceed carefully.

There is (1) the mechanical efficiency of the pump or ejector; (2) the overall efficiency, including the power employed, be it electric motor, steam, gas or oil engine, plus, in the case of the ejector, the air compressor; (3) the commercial efficiency; and (4) last, but not least, the sanitary efficiency.

The first and second are the difference between the foot pounds raised per minute divided by 33,000 and the h.p. consumed, and the third is the annual cost of lifting plus maintenance and capital charges. Cost of maintenance may vary considerably and by inference; the cheapest initial outlay may not be the most economical. Four may be described as work done with the least nuisance.

With regard to the overall efficiencies of the three methods, I have found it impossible to obtain any figures strictly comparable, so have recourse to such as are available. In the case of centrifugal pumps, I have utilized the results obtained in the trials referred to, which are as follows:

Pump efficiency	80	per cent
Overall efficiency	65.3	per cent

These are calculated on total head, which is the accepted method. I have also just for curiosity worked them out on the 11-ft. static head, and get:

Pump efficiency	42.8	per cent
Overall efficiency	34.6	per cent

The efficiency of the motor has been taken as 81 per cent.

For the efficiency of reciprocating pumps and ejectors I have taken the liberty of quoting from "The Efficiency of Pumps and Ejectors," by E. C. Bowden-Smith, M.I.M.E., who gives the results of tests of the former as 90.88 per cent and 92.8 per cent on a total head of 144 ft. and 134 ft. respectively and an output of 3,235 gallons per minute.

These are probably on the high side, being taken under favorable plant conditions. The engine was a quadruple expansion type 155 to 195 indicated h.p. direct coupled to a three-throw single-acting ram pump 21½ in. by 3 ft. Personally I should prefer to base calculations on about 75 per cent for a unit of moderate size. The latter was 36.2 per cent as the result of ejector stations raising 227,291,000 gallons with heads of from 41 to 46 ft. This overall efficiency includes loss in air mains, compressors and ejectors.

Messrs. Hughes and Lancaster claim that the mechanical efficiency of the "Shone" ejector is 98 per cent, the only loss being 1 per cent past the flap valves and 1 per cent leakage throughout the automatic valve.

The commercial efficiency is more difficult to calculate, and, I am afraid, cannot be reduced to figures; but undoubtedly the initial cost of centrifugal pumps is lower than either of the others, and if the lift is moderate and the mechanical efficiency can be maintained, would probably take first place.

The sanitary efficiency would in all circumstances be determined by local conditions. As an illustration it may be pointed out that an ejector station might be more hygienic than an underground pumping plant.

Factors to be Considered in Selecting Method

Local conditions must necessarily govern to a large extent the choice of method, and we can here use the old argument of the sanitary engineer in regard to sewage—that every town must be treated on its merits, there being no universal panacea. But I should like briefly to summarize my opinion as follows:

Centrifugal pumps for heads not exceeding 50 ft.

Reciprocating pumps for over 50 ft., and in cases where there is a long rising main.

Ejectors where there is no natural fall, and in water-logged subsoil where the cost of laying deep sewers would be prohibitive.

In practice it is stated 55 to 65 ft. head is the maximum for economical working, but 45 ft. is to be preferred, the frictional head on the cast-iron main accounting for a large percentage of the pressure; but this can be arranged by having subsidiary stations and thus reducing the working pressure.

There is one thing in connection with the running of ejectors that has struck me. It is necessary to keep up the air pressure for the maximum lift, although during certain times of the day the capacity of the compressor is greater than the requirements, and a cut-out device is usually fitted on the compressor so that it runs light. This on some systems may amount to many hours per day, and although the power consumed is small, nevertheless it adds to the total cost. It is difficult to avoid, as one cannot see the contents of the sewers. I know, of course, that in some cases it is usual to shut down during the slack hours of the day, but, given a gravitation and pumping scheme, one can arrange the pump units to keep pace with the flow, which is under observation the whole time, and I should like to hear suggestions for the solution of this difficulty. Abstract of paper read at the Annual Meeting of the Association of Managers of Sewage Disposal Works.

Speaking at the banquet of the Canadian National Clay Products Association last Wednesday in Toronto, J. B. Carswell, president of the Building and Construction Industries Association, said that "this business depression is an empty cocoon. I feel sure that the depression in our line is over, and in that I express the conviction of three hundred men who met at that convention. The element of the rise in British exchange would be an important factor in stimulating building by providing money. As soon as the exchange rights itself and money can come here without loss there will be an improvement," he said. With a building boom the industry would still have its problems. In Toronto, for instance, he doubted whether there would be enough building mechanics and certain material to meet the demands.

CLAY PRODUCTS ASSOCIATION HOLD ANNUAL MEETING

THE 20th annual meeting of the Canadian National Clay Products Association was held in Toronto on Feb. 7. The convention brought together a representative gathering of men prominent in the various branches of the clay products industry in Canada. President Ryland H. New of Hamilton in the opening address said: "The time has come when we must look ahead and broaden out in all lines of our work. With building conditions improving, the need of, and demand for, all lines of clay products will become greater, and it is for our own good that we produce the best possible article and satisfy the dealers, architects and the public with the quality of the goods they are buying."

Prof. W. G. Worcester, of the University of Saskatchewan told of the extensive work started in that province. A survey which had been commenced already has shown Saskatchewan to be exceptionally rich in the natural resources necessary for clay and brick products. Tests so far made had shown the existence of fire clays, china clays, terra cotta clays and clays suitable for the manufacture of paving, brick and buff and red-faced brick, and for the uses of paint and paper manufacturers. Officers elected were: President, Ryland H. New, Hamilton (re-elected); 1st vice-president, T. H. Graham, Inglewood; 2nd vice-president, Andrew Dods, Mimico; 3rd vice-president, D. C. Merkeley, Ottawa; Secretary, Gordon Kelth, Toronto and Councillors W. J. Nicholson, Toronto; H. H. Hallatt, Tillbury; F. B. McFarran, Toronto; Ray Price, Humber Bay; N. T. Canon, Montreal; C. B. Lewis, Toronto; C. H. Wallace, Toronto, and Robert New, Hamilton.

The Koehring Company of Canada, Ltd., has just been organized with a Dominion charter with head office at 105 Front St. E., Toronto. It is the purpose of this company to handle the sale of Koehring construction type mixers, Koehring pavers, Koehring cranes and other construction and industrial plant equipment including Whitcomb gasoline and storage battery locomotives, C. H. & E. saw rigs, pumps, hoists, etc. The company will carry a complete stock of Koehring mixers and pavers together with a stock of spare parts for these same machines. By this means the purchasers of Koehring products and other products sold by the Koehring Company of Canada will be assured of prompt and satisfactory service by men who are fully experienced in this class of work and who are alive to the requirements of engineers and contractors who are interested in the use of machinery of this kind.

A bill has been introduced before Congress at Washington, by Representative Reed, of New York, to authorize the construction of a ship canal from Lake Erie to Hudson River. The canal as proposed will be 30 ft. deep and 300 ft. wide. It will have one terminal at Buffalo and the other on the Hudson River at Kenwood, near Albany.



BEFORE AFTER
Or, What the Good Roads Movement Means in Ontario

ANNUAL CONVENTION OF ASSOCIATION OF DOMINION LAND SURVEYORS

Report of Fifteenth Annual Convention Held in Ottawa—
Association in Flourishing Condition—Several Interest-
ing Papers Read at Sessions—Election of Officers

THE fifteenth annual convention of the Association of Dominion Land Surveyors was opened on Wednesday, morning, Feb. 1, in Victoria Museum, Ottawa, with about 90 delegates, representing the membership of the association in Ontario, Quebec, and the Western provinces in attendance. The president, G. H. Blanchet, Ottawa, in a few well chosen words welcomed the visiting members to the convention and expressed the hope that they would find the proceedings of the meetings both interesting and instructive.

President's Address

The President reviewed the work of the surveyors from the earlier periods contrasting the differences in the nature of the first surveys to those which are required to meet the developments of settlement in the Western provinces at the present time. He said the pressing need in the early settlement of the country was to mark the boundaries ahead of the squatters and homesteaders, but as the great plains of fertile lands were surveyed and settled a new field of service was opened up to the surveyor. It became necessary to explore the land and examine it with a view to determining its possibilities as an agricultural district and to define more or less definitely the limits of such areas.

This matter became acute when the Government undertook a soldier settlement scheme to provide homes for the men who had defended our country in the late war. Large areas were examined and reported upon and the Department was able to select lands where the settler had a reasonable chance of success.

Mr. Blanchet also pointed out that surveyors should learn to impart to the public in an interesting and forcible manner, the information they gather relative to the country covered by their work.

T. B. Spieght, Toronto, and Jacob L. Doupe, Winnipeg, expressed their appreciation of the work of the association.

The Secretary's report was submitted showing a membership in excess of 225 and a strong financial condition.

Speakers at Annual Luncheon

The annual luncheon on Wednesday in the Chateau Laurier was attended by 115 members and their guests, and in every way was one of the most successful ever held by the association. Among the guests were the Hon. Chas. Stewart, Minister of the Interior; Dr. E. Deville, Commissioner of Dominion Land Surveys; Dr. W. J. Roche, Chairman Civil Service Commission, and others prominent in professional and departmental work.

The Minister of the Interior in a short address spoke of the work of the surveyor, pointing out that in addition to his technical duties it was necessary, at times, for him to exercise great diplomacy in dealing with cases of disputed boundaries between settlers. He spoke also of the difficulties confronting this country in getting back to normal conditions after the great war but assured the audience that Canada was making good progress and that Western Canada offered great opportunities to the young man who was willing to work. Work, he said, and co-operation, would soon solve the financial difficulties of the country.

Dr. Deville spoke of the different branches of survey work, giving a brief outline of the extent of the precise levelling operations, topographical and revisional surveys along the Mackenzie where 4,000 miles were surveyed last season and other miscellaneous classes of work.

Dr. Roche in his usual happy manner mentioned the Imperial Conference and the Peace Conference pointing out that Canada was taking her place in the world councils. He also invited the co-operation of the association for the

purpose of improving the general efficiency of the Civil Service.

Papers Read at Afternoon Session

In the afternoon addresses were given by Capt. Forrester and Mr. Lloyd, of the Dominion Parks Branch, on "Our National Parks and Bird Sanctuaries." In the course of his remarks on "Bird Sanctuaries" Mr. Lloyd pointed out, that, to protect our birds, two things were necessary, viz., protection of the breeding grounds and closed seasons for shooting. Surveyors, he said, in view of their wide travels in the wilds should be able to render valuable assistance, by reporting to the Government, the location of breeding grounds of the birds. Continuing he pointed out that the "Trumpeter Swan" and the "Whooping Crane" (white turkey) were nearly extinct. Recently 19 of these swans were found in Alberta and these, he said, were the only ones known to exist.

L. J. Bowes gave a short paper on Hydrographical Surveying in James Bay. He explained in detail the methods adopted in carrying out soundings, and pointed out the great need of properly charted waterways. Canada should be proud of her waterways and the manner in which they were buoyed and lighted.

Paper on Photographic Surveying

Perhaps one of the best papers given at the Convention was that presented by M. P. Bridgland on Photographic Surveying. His paper, although necessarily of a technical nature, was clear and explained the work fully from the manner of selecting the camera stations to the completion of the map. Photographic methods, he said, were not applicable to every class of country but was particularly adapted in rugged country and where it is desired to cover large areas at a low cost. The instruments used in the field are the transit and the camera which are especially constructed for transport in climbing mountains. Wratten & Wainwright panchromatic plates $4\frac{1}{4}$ in. x $6\frac{1}{2}$ in. are used. These plates are very sensitive and excellent pictures are obtained. Special instruments for plotting have been devised and Mr. Bridgland, by a number of slides, gave a clear description of these models. He explained the manner of control by triangulation and how the position and elevation of points were determined from the photos. Storms and unfavorable weather conditions in the high altitudes were, he said, some of the greatest difficulties to overcome. A number of slides showing the mountains in all their wild grandeur were very much appreciated by the large audience. A full report of Mr. Bridgland's paper will appear in a later issue of "The Canadian Engineer."

Another interesting and instructive paper "A Trip Down the Mackenzie" was presented by F. V. Seibert. In illustrating his address Mr. Seibert used over 100 slides from which one could obtain a really good idea of the great river and the country of the promised "Oil Wells." The views covered a distance of 1400 miles from Fort McMurray to Carceyon river, 105 miles below Norman.

In addition to showing views of the country Mr. Seibert explained the manner of transport of the government survey parties down the river and by means of some excellent views was able to convey to the audience a clear understanding of the pleasures, hardships and adventures encountered on these trips. Mr. Seibert explained also the methods adopted in carrying on the survey down the river in which three parties in $2\frac{1}{2}$ months actually surveyed over 4,000 miles of shore line.

Work of Air Board in Canada

In the evening an illustrated lecture by J. A. Wilson on the "Work of the Air Board in Canada" was much appreciated by a large audience of surveyors and their friends. Mr. Wilson explained that Canada possessed a large number of trained flyers and while it was impossible to maintain a large military force of aeroplanes it was hoped that useful work could be found for a number of officers and men. Aviation comprised three classes, civil, defence and commercial. In Canada the absence of large centres

of population mitigated against commercial aviation, but he said that in the near future Montreal and the Pacific would be connected by aeroplane.

The Air Board had taken over Camp Borden and here provided instruction for those wishing to enter the school. About 30 officers and 200 men were actually employed, but Canada could provide in case of need 5,000 officers and men. 500 officers and 1,100 men had passed through the school during the last 15 months.

Mr. Wilson explained the work done by the air service in connection with forest patrol and told of instances where small outbreaks of fire were detected and put out before any damage could be done.

Another phase of the work was assisting in fisheries control for the prevention of poaching and also the mapping of the St. Lawrence for the International Waterways Commission.

Officers Elected for Ensuing Year

Officers elected for 1922 were as follows: President, G. H. Herriot, Winnipeg; vice-president, D. H. Nelles, Ottawa; sec.-treas., W. L. MacIquham, Ottawa; Councillors for Ottawa; J. W. Pierce, Ottawa; B. H. Segre, Ottawa; A. M. Perry, Ottawa; J. E. R. Ross, Ottawa; T. H. G. Clunn, Ottawa. Councillors for Quebec: E. F. Gorman, Buckingham, Que. Councillors for Ontario: E. P. Bowman, West Montrose, Ont., and T. W. Beattie, Pembroke, Ont. Councillors for Saskatchewan: W. M. Stewart, Saskatoon, Sask., and W. R. Reilly, Regina, Sask. Councillors for Alberta: H. E. Pearson, Edmonton, and J. B. Alexander, Calgary. Councillors for Manitoba: W. E. Hobbs, Winnipeg, and C. E. Joslyn, Winnipeg. Councillors for British Columbia: J. E. Umbach, Victoria, and E. C. Coursier, Revelstoke.

UNIVERSITY OF MICHIGAN HIGHWAY CONFERENCE

AN interesting program has been arranged for the eighth annual conference on Highway Engineering which will be held at the University of Michigan, Ann Arbor, Mich., on February 13 to 17, 1922. The conference will be held under the direction of the College of Engineers in co-operation with the Michigan State Highway Department. The program is as follows:

Monday, February 13, 8:00 a.m.

Registration, Room 407, Engineering Building.

Monday, February 13, 2:30 p.m.

Henry E. Riggs, Professor of Civil Engineering, University of Michigan, presiding.

"New State Standard Cross-Sections, Shallow Ditches and Sub-Drainage," Leslie H. Belknap, Deputy State Highway Commissioner of Michigan.

"State Investigations Covering Grade Reductions," V. R. Burton, District Engineer, Michigan State Highway Department, and Walter E. Lay, Assistant Professor of Mechanical Engineering, University of Michigan.

Monday, February 13, 8:00 p.m.

Moving Pictures of Road Machinery and Highway Construction Methods, Room 348, Engineering Building.

Tuesday, February 14, 9:30 a.m.

Frank F. Rogers, State Highway Commissioner of Michigan, presiding.

"Controlling the Quality of Materials in Highway Construction and Maintenance," John H. Bateman, Director, State Highway Laboratory, and Assistant Professor of Highway Engineering, University of Michigan.

"Efficient Methods of Providing for Traffic During Highway Construction," A. R. Hirst, State Highway Engineer of Wisconsin.

Tuesday, February 14, 2:00 p.m.

G. C. Dillman, Maintenance Engineer, Michigan State Highway Department, presiding.

"Plant Inspection, a Necessity to Insure Good Bituminous Pavements," Francis P. Smith, Consulting Paving Engineer, New York City.

"Developments of Constructing Brick Pavements," Arthur H. Blanchard, Professor of Highway Engineering and Highway Transport, University of Michigan.

Tuesday, February 14, 8:00 p.m.

Smoker: Michigan Union, Second Floor, Henry E. Riggs, Professor of Civil Engineering, University of Michigan, presiding.

"Michigan as a Summer Resort," Hon. H. S. Earle, former State Highway Commissioner of Michigan.

Violin Solo by M. L. Casman, Roy D. Chaplin, Fellow in Highway Transport.

Songs by Highway Engineering Students.

Musical Selections by Rogers' Orchestra.

Wednesday, February 15, 9:30 a.m.

Arthur H. Blanchard, Professor of Highway Engineering and Highway Transport, University of Michigan, presiding.

"Bituminous Surfaces on Gravel Roads," Paul D. Sargent, Chief Engineer, Maine State Highway Commission.

"State Investigations Covering Dust Prevention on and Preservation of Gravel Roads," G. C. Dillman, Maintenance Engineer, Michigan State Highway Department, and Herschel C. Smith, Assistant Professor of Highway Engineering, University of Michigan.

Wednesday, February 15, 2:00 p.m.

L. H. Nelson, Deputy State Highway Commissioner of Michigan, presiding.

"Comparison of Sub-Drainage by Deep Side Ditches and Tile Drains," Charles M. Upham, State Highway Engineer of North Carolina.

"Organization, Management and Methods of Snow Removal from Highways Outside of Municipalities," Charles J. Bennett, State Highway Commissioner of Connecticut.

Wednesday, February 15, 8:00 p.m.

Moving Pictures of Road Machinery and Highway Construction Methods, Room 348, Engineering Building.

ROAD COMMISSIONERS' MEETING

Thursday, February 16, 9:30 a.m.

Frank F. Rogers, State Highway Commissioner of Michigan, presiding.

Reports of representatives of the County Highway Departments of Michigan.

Thursday, February 16, 2:00 p.m.

Leslie H. Belknap, Deputy State Highway Commissioner of Michigan, presiding.

"Distribution of State Reward Funds," Frank F. Rogers, State Highway Commissioner of Michigan.

"Maintenance of State Trunk Line Roads in Calhoun County," G. W. Schneider, Chairman, Calhoun County Road Commission.

Thursday, February 16, 6:00 p.m.

Informal Dinner of Michigan Road Commissioners' and Engineers' Association: Banquet Hall, Michigan Union. President, G. W. Schneider, presiding.

Friday, February 17, 9:30 a.m.

Filbert Roth, Professor of Forestry, University of Michigan, presiding.

"Appearance of Highways," C. F. Boehler, Landscape Engineer, Michigan State Highway Department.

"Useful Roadside Planting," Hon. W. S. Linton, Saginaw, Michigan.

"Growth of Roadside Trees," A. K. Chittenden, Professor of Forestry, Michigan Agricultural College.

"Relation of Roadside Development to Telephone Companies," B. R. Marsh, Division Plant Superintendent, Michigan State Telephone Company.

Commissioner of Works Andrew F. Macallum, of Ottawa, has been instructed to find a street railway expert to co-operate with the City of Ottawa in drafting a new franchise agreement with the Ottawa Electric Railway.

ALTERATIONS TO OLD BOARD OF TRADE BUILDING, TORONTO

Interior Bearing Walls Removed and Columns and Girders Substituted. Old Structural Steel Found to Be in Perfect Condition

VERY extensive alterations to the interior of the old Board of Trade building, at the corner of Yonge and Front streets, Toronto, Ont., have been almost completed. Three storeys are to be added to the old eight-storey building and a ten-storey addition is to be built adjoining the present building. The extensive use of structural steel throughout the operations has made it possible to change this old out-of-date building into an office building of the highest class. Although thirty-five years have elapsed since the old structural steel was erected, it is in such good condition that many beams which were removed were put back into the new work; some of the old beams being found to be of a size and weight that are no longer manufactured.

The Board of Trade building was built about thirty-five years ago and is of the bearing wall type. The floors consist of a flat tile arch resting on steel-I-beams in turn rest on bearing walls. A few cast iron columns were used between the first floor and second floor to give a clear space on the ground floor. They were marble covered and set in a circle in the centre of the building. Above these columns the interior bearing walls ran up to the sixth floor.

Around the curved front of the building were a few built-up columns running from the basement up to, and carrying, the trusses that support the large dome. These columns were not in the outside walls but were offset about eighteen inches from them. In the basement storey several cast iron columns were found supporting the steel I-beams about 4 ft. from the walls. This is a very unusual piece of construction and there seems to be no reason why such a method should be employed unless it was to take some of the load off the walls on a separate footing and shorten the length of the span of the I-beams. If this were true it was a case of a very doubtful economy. This condition obtained also near of the interior bearing walls where columns were placed under some of the floor beams a short distance from the wall. The peculiar part of it is, however, that these columns ran only for a floor or two at one time and then when they were continued after missing a storey or two they were not directly above the lower columns. Why these columns were put in, no one seems to know but it shows how much the art of designing steel structures has progressed in the last few years.

The major portion of the alterations was the removal of all interior bearing walls, replacing them with steel columns and I-beams, the floors being left intact. It was a very complicated piece of reconstruction as there were no plans available and when the survey and preliminary plans were made the tenants had not moved out so that the position of the floor beams had to be determined from the ceiling of the basement, the upper floor beams being assumed to be in the same relative position. As the work progressed, however, it was found that this was not the case and each individual column and beam had to be treated independently and most of the connections were designed on the job.

In place of shoring all the floors at the same time from the bottom to the roof, as is very often done in a case of this kind a new idea was employed to take out the bearing walls without disturbing the floors. The columns and foundations were designed to carry the future floors and were spliced at every floor. The work of placing the columns was commenced in the basement. Here directly above the column foundation, needles were inserted through the wall and enough of the wall removed to allow the foundations to be placed. When the grillage had been placed, the hole in the wall was bricked up with the exception of a chase left in the wall in

which the column was placed from the basement to the first floor. The second floor was shored up around the column, a chase cut in the wall, and the second tier column placed. This operation was repeated for every floor to the roof, temporary steel supports being provided for any beams that were intercepted by the new column. In some cases the new column ran through one of the old steel beams and it was necessary to cut a piece out of the beam to allow the column to pass. The beam being temporarily supported on the new column.

After the columns had been erected the roof was shored up and the walls were torn down to the next floor. Steel girders were inserted to take the place of the wall and the roof beams were framed into girders. These new girders at the roof level was placed at the elevation of the new floor that is to be erected and consequently only temporary bolted connections were used for the present roof beams. Shores were placed under the floors, the walls torn down and girders erected to take their place till all the old bearing walls were removed.

The round circular portion where the vaults were located, was treated in a similar manner but it presented a more difficult problem in that it was necessary to remove the columns supporting the dome trusses and the beams framing into these columns had to be taken care of. On account of the peculiar shape of the building, very often as many as six or seven beams framed into the column from different directions and the majority of these had to be burned off and spliced, using often, a bevelled connection to transfer the load to the new column.

The whole operation was a tedious one as it was impossible to design the steel or connections till the floor and wall was torn up and most of the work was done in the field. The steel contractor kept a man constantly using the oxy-acetylene flame burning off beams and columns from the time the first piece of steel was erected.

The remarkable accuracy with which structural steel can be erected under most impossible conditions is demonstrated by the fact that the maximum amount any column was out of plumb in the eight storeys was one-half inch.

The present contract called for the tearing out of the interior bearing walls and replacing them with steel beams and columns while the remodelling of the dome, the addition of three new storeys and the erection of a ten-storey addition to the east of the present building is included in a new contract which is out for tender now.

The engineering as well as the architectural work is being handled by Messrs. Dowsell and Dolphin, architects. The Carswell Construction Co., are the general contractors, and the structural steel is being supplied and erected by The Dominion Bridge Co. Ltd., Toronto. Great credit is due the latter company for the efficient manner in which the work was handled under very trying conditions.

Speaking in Hamilton, Ont., recently the Hon. F. C. Biggs, Minister of Public Works for Ontario, said that by July 1 he hoped to have the Hamilton entrance of the Toronto-Hamilton Highway completed. Early in the year, it was expected, he added, to have the Hamilton-St. Catharines Highway finished, and the Hamilton-Brantford Road, which drives would connect Toronto, Owen Sound, Welland, Dundas Street, Guelph and other centres.

In the United States approximately \$400,000,000 was spent on road construction in 1919; in 1920 about \$600,000,000, and it is estimated that for 1921 approximately \$800,000,000 was spent. For this year nearly one and one-half billion dollars are available for road construction and it is expected that actual cash expenditures will pass the billion dollar mark. More money is now being spent on road construction than on all other public works combined.

CONFERENCE ON ROAD CONSTRUCTION

THE Eighth Annual Conference on Road Construction for county road superintendents and engineers will be held in the Parliament Buildings, Toronto, on Monday and Tuesday, February 27 and 28, 1922.

During the same week, viz., on March 1, 2 and 3, the Twentieth Annual Meeting of the Ontario Good Roads Association will be held in the York County Buildings, 57 Adelaide Street East, Toronto.

The accompanying programme gives an outline of the subjects which will be discussed at the Conference on Road Construction. Each subject will be introduced by a short address by the speakers whose names are shown on the programme, and the meeting will then be open for discussion.

The county and township road superintendents and engineers are strongly urged to arrange to be present at all of the sessions of the Conference, and also to attend the meeting of the Ontario Good Roads Association.

The Department of Highways requests that all those planning to attend the Conference will indicate their intention by letter as soon as possible, in order that a sufficiently large lecture room may be secured. All communications should be addressed to the conference chairman, W. A. McLean, Deputy Minister of Highways, Toronto.

MONDAY, FEBRUARY 27TH

Morning Session

10:00 a.m.—"Road Drainage," Geo. McCubbin, county engineer of Lambton.

Discussion introduced by U. W. Christie, Dufferin county engineer, and J. G. Cameron, county engineer of Stormont, Dundas and Glengarry.

11:00 a.m.—"The Beautifying of our Highways," H. J. Moore, Forester, Department of Public Highways.

Afternoon Session

2:00 p.m.—Address, Hon. F. C. Biggs, Minister of Public Works and Highways.

3:00 p.m.—"Concrete Bridges and Culverts," W. J. Moore, Renfrew County Engineer.

Discussion introduced by John Young, Wellington County Road Superintendent, and W. J. Kean, Ontario County Engineer.

TUESDAY, FEBRUARY 28TH

Morning Session

9:30 a.m.—"Concrete Road Surfaces," L. A. Pardo, Kent County Road Superintendent.

Discussion introduced by L. S. Lichty, Waterloo County Road Superintendent.

11:00 a.m.—"Gravel and Stone Road Maintenance," Frank Pineo, Elgin County Road Superintendent.

Discussion introduced by R. H. Fair, Frontenac County Road Superintendent, and S. Fox, Hastings County Road Superintendent.

Afternoon Session

2:00 p.m.—"Bituminous Road Surfaces," Alan K. Hay, Engineer to Ottawa Suburban Road Commission.

Discussion introduced by G. Marston, Norfolk County Engineer, and Wm. Waters, Lanark County Road Superintendent.

3:30 p.m.—"The Early Preparation of County Road Programmes," Frank N. Rutherford, Lincoln County Engineer.

Discussion introduced by E. L. Miles, Victoria County Engineer, and N. L. Powell, Peel County Engineer.

A two-day session, with interesting papers, discussions and an address from Hon. F. C. Biggs, Minister of Highways, has been arranged for the eighth annual conference on road construction, which meets in Toronto on Monday and Tuesday, February 27 and 28. During the same week, March 1, 2 and 3, the twentieth annual meeting of the Ontario Good Roads Association will be held in the York County Buildings.

NEW PUBLICATIONS

A Compilation of Town Planning Legislation by Horace L. Seymour. A re-print of an article bearing this title which appeared recently in "The Canadian Engineer," embodying a compilation of Ontario legislation dealing with Town Planning methods. The compilation represents the author's efforts to get together material in a comprehensive form so that Ontario town planning legislation can be reviewed and readily compared with that of other provinces and countries.

The Canadian Ingersoll-Rand Company has just issued bulletin No. 10102 which is devoted to the illustrating and describing of their Price-Rathbun type oil engine. These engines are the vertical, single-acting, direct injection type operating on a four stroke cycle. Very minute and interesting details of the method of construction of these engines are given in the pamphlet which contains twenty-eight pages. The oil engine is fast coming into its own as a prime mover and to those interested this bulletin will be found very valuable. It is very adequately illustrated and altogether an attractive piece of trade literature.

The Pelton Water Wheel Co., of San Francisco and New York, has issued Bulletin No. 17, "Pelton Water Wheels (Impulse Turbines) and Reaction Turbines." The bulletin describes the various types of hydraulic equipment manufactured by the company, and discusses their application both to the generation of hydro-electric power and to the direct operation of many different kinds of machinery. Some space is also devoted to governors and to pressure regulating devices. The bulletin comprises 48 pages and is illustrated by a number of drawings and photographs. Copies may be obtained upon application to either office of the company.

Multi-Type Condensers. Bulletin No. 9032, issued by the Canadian Ingersoll-Rand Co., Sherbrooke, Que., describes their low level multi-jet type condensers for steam plants. In this type of condenser the most efficient action is obtained with multiple jets giving a large exposed surface for condensation. The bulletin describes fully the construction and method of operation and deals at length with the high vacuum produced with this type of condenser; in this connection an efficiency and capacity chart is shown of a centrifugal pump working at different suction lifts. Copies of this bulletin, which is fully illustrated, may be obtained from the head office of the company or from any of the branches.

The Canadian Municipal Equipment Corporation, Ltd., Bank of Hamilton Bldg., Toronto, has just issued a most interesting booklet illustrating and describing the "Otterson Auto-Eductor," the new and sanitary method of cleaning catch basins. This machine has again and again demonstrated its usefulness and superiority over the old flush method of cleaning catch basins and will undoubtedly appeal to city engineers and others responsible for the maintenance of sewers. The utilitarian character of this piece of equipment, in addition to its usefulness in cleaning catch basins, will be evidenced when it is stated that for very little extra cost the machine can be made to function as a street flusher, sprinkler and in some instances it has been used as an emergency pumper, auxiliary to the fire department. The pamphlet contains 16 pages and is well illustrated, and all those who have to do with the problems of sewer maintenance would do well to write for a copy.

At a meeting of the Alberta Association of Architects Professor C. S. Burgess of Edmonton was elected president. Other officers chosen were: George Fordyce, Calgary, first vice-president; E. W. Morehouse, Edmonton, second vice-president; A. M. Calderon, Edmonton, representative to the senate of the University of Alberta; E. Underwood, Edmonton, secretary; W. G. Blakey, Edmonton, treasurer; F. Vigers and J. Martland, auditors.

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BRIDGES VERSUS TUNNELS

PROMPTED by the agitation for the construction of a combined railway and highway bridge over the North river at New York at a time when the new vehicular tunnel is in process of construction, there has arisen a vigorous discussion of the respective merits of bridges and tunnels for crossing navigable waters. While some engineers who have had special experience in one or other of the two fields of construction involved are disposed to take a somewhat partisan attitude in favor of the type of construction with which they are most familiar, it should be recognized that there is no hard and fast rule applicable to all crossings and to all classes of traffic by which the economic relation of these two types of project can be forecasted in an offhand manner. There is too great a disposition to advocate the construction of a bridge or a tunnel because in some other locality such a work has been successfully carried out and put into operation. What is suitable for one situation may be entirely unsuitable for another. One which might have some points in common with the first. Even for the same general district both bridges and tunnels have been built and probably there was merit in each for the particular site. Thus, there are both bridges and tunnels across the East river at New York, across the Chicago river at Chicago and across the Thames at London and the Seine at Paris.

A basic point that should not be forgotten in economic comparisons of this kind is that the facilities offered by the competing bridge and tunnel should be exactly equal. It affords no true indication of the respective merits of these two types of works to pit a double track railway tunnel against a double track railway bridge

providing also facility for highway traffic. Not only should the same number of tracks and the same total widths of roadway be provided in the two schemes, but the arrangement should be such that equal movements of traffic could be accommodated, if the comparison is to be a fair one. Thus, it cannot be said that two single roadway tunnels would be equivalent in traffic facility to one bridge roadway proportioned for two lines of traffic. In the first instance a breakdown of a vehicle in one of the single roadway tunnels would completely block traffic in that direction, whereas on a bridge, traffic could be kept moving by making detours around the stalled vehicle.

Comparison of the economic characteristics of tunnel transport with that provided by a bridge usually results in pitting several small tunnels against one bridge. This arises from the fact that the cost per lineal foot of a tunnel varies nearly as the square of the diameter, and it is therefore advantageous to keep the diameter small. So far it has not been found advantageous to use an outside diameter of the shell greater than 30 ft., which was the diameter used for the Rotherhithe tunnel under the Thames in London.

The height of the shores in the vicinity of the crossing has an important bearing on the relative economy of bridges and tunnels. If the shores be low and if a considerable overhead clearance has to be provided for ships, the profile is favorable to the tunnel in that less deviation from grade in the vicinity is necessary and the approaches are much shorter. If, on the other hand, the shores are high and a large overhead clearance for ships must be provided, the situation is favorable to the bridge for a corresponding reason. For situations such as exist at the Canal St. crossing at New York where the shores are fairly low and the clearance for ships must be high, the amount of energy consumed in hauling loaded vehicles up from a dip of perhaps 90 ft. below water level is manifestly much less than in hauling them up a bridge approach to an elevation of perhaps 150 ft. above water level.

Some advantage accrues to the tunnel through the possibility of extending the service provided thereby by the simple expedient of constructing several more tunnels, whereas it is usually difficult to increase the capacity of a bridge once built. This, however, is not impossible if the bridge is originally constructed so as to provide for the addition of another traffic deck.

In general it may be said that the cost of approaches for a bridge carrying steam railway traffic is higher than for a tunnel carrying the same class of traffic. At the same time property damages are also more. The maintenance charges for a tunnel so far as keeping it in condition is concerned are much less for tunnels than for bridges, but, on the other hand, the operating costs, apart from the loss of energy in hauling traffic up heavier grades for a bridge, are greater for the tunnel. The matters of lighting and ventilation do not, of course, enter into the bridge project in any important degree.

While electrically operated tunnels may accommodate the traffic with no more risk than is involved in the operation of a bridge, considerable concern is expressed by many engineers with respect to the practicability of operating vehicular tunnels accommodating motor driven traffic. Everyone is familiar even in the open with the large amount of gas given off by motor vehicles, and fears are expressed lest the breakdown of a motor vehicle in a tunnel or the possible burning of one might not bring about a disaster of unparalleled magnitude. Investigation has shown that a considerable quantity of carbon monoxide is given off by motor vehicles, and apart from the combustible character of this gas, its cumulative poisonous effects are well established. It is evident, therefore, that a vehicular tunnel of any appreciable length cannot be operated safely without a most efficient and reliable system of forced ventilation. The disagreeable atmosphere in the Rotherhithe tunnel accommodating relatively few motor vehicles without forced ventilation is an indication of the necessity of such equipment.

It should be stated, however, in fairness to those charged with the construction of the vehicular tunnel under the Hudson river that the decision to construct a tunnel was not arrived at without conducting the most exhaustive investigations with respect to the possibility of keeping the atmosphere in the tunnel in a sufficiently pure state to make traffic safe. Investigations carried out through the co-operation of the University of Illinois and Yale University with the United States Bureau of Mines have shown that a carbon monoxide content of four parts in ten thousand, would not be injurious to persons using the tunnel. The engineers therefore have definite experimental evidence upon which to base their provisions for ventilation, but at the same time it must be admitted that a risk is being taken in this matter which does not need to be taken in the construction of a bridge.

Apart from the hazards, either real or imaginary, of vehicular tunnel construction and the relative opening difficulties the economic facts of the situation should control the adoption of the type of crossing. Experience gained through the construction of many such works has shown that while tunnels are likely to be cheaper for steam railway and electric railway traffic they are more expensive than bridges for highway traffic. The deeper the navigable water crossed and therefore the longer the main bridge span needs to be, the more is the tunnel favored, but even up to about a 3,000-ft. span the bridge is economically superior to the tunnel for highway traffic. Appreciation of this fact has led some engineers to propose that railway traffic both steam and electric for crossings of navigable waters be carried across through tunnels, and highway traffic be accommodated by bridges. The heavier grades necessitated on the bridge do not much concern the autoist either in the matter of fuel consumption or time lost, but they do vitally concern the railways. Wherever the possibility of the use of short spans for a bridge crossing exists, a bridge will be decidedly of advantage as compared with tunnels, and even though the span be very long, as has been already noted, the highway bridge is able to compete to advantage with the tunnel.

An important feature of the situation is the greater risk and cost uncertainty involved in the construction of tunnels. Commenting on the whole situation of bridge vs. tunnel, "Engineering News" observed some years ago while the Pennsylvania tunnels for the New York entrance were under construction, that there was reason to believe that if the Pennsylvania Railroad had known before earmarking on the venture all that it knew at the time of writing concerning the relative costs of ridges and tunnels, that it would have chosen bridge entrances to Manhattan.

PERSONALS

RYLAND H. NEW, of Hamilton, Ont., has been elected president of the Canadian National Clay Products Association.

G. H. DUNCAN, of Peterborough, Ont., has been elected president of the Peterborough Builders' and Supply Association.

WILLIAM P. DALE has been appointed township engineer and road superintendent for the Township of Stamford, Ont.

HON. HEWITT W. BOSTOCK, who recently retired from the Ministry of Public Works in the Dominion Government, has been appointed Speaker of the Senate. Senator Bostock will take over his new office at once.

DR. MILTON HERSEY and E. DAOUST have been appointed Harbor Commissioners to the Port of Montreal. Both the new commissioners are residents of Montreal and have taken an active part in the commercial life of that city. Dr. Hersey is president of Milton Hersey Co., Ltd., Montreal, industrial chemists and consulting engineers, and conducts one of the largest testing laboratories in Canada.

MAJOR ROBERT MCKNIGHT, of Owen Sound, Ont., has been appointed engineer for the County of Grey. Major

McKnight graduated from McGill University and the Royal Military College, Kingston. He was for some years employed on construction of the Grand Trunk Pacific and was later engaged upon engineering work in the West. Major McKnight went overseas with a Western unit in 1914 and returned to Owen Sound at the conclusion of hostilities.

PROF. H. R. CHRISTIE has been appointed professor in the faculty of forestry at Toronto University. Prof. Christie is at present Professor of Forestry in the University of British Columbia. He graduated from the University of Toronto in 1912, and was for a time connected with the Forestry Department of the British Columbia Government. During the war he was with the Canadian Engineers in France, where he was wounded, and later with the forces in Siberia.

W. A. ALEXANDER has been appointed district engineer in charge of the Helena, Montana, office of the Portland Cement Association. Mr. Alexander's experience in the engineering and contracting field extends over a number of years, and covers railroading, irrigation, drainage and hydro-electric engineering. About a year ago Mr. Alexander entered the employ of the Portland Cement Association, and has since been conducting educational and promotional work in Southern Idaho.

COL. R. W. LEONARD, M.E.I.C., of St. Catharines, Ont., has been presented with the Leonard medal. For two years past this medal has been awarded, but the first presentation of these medals was made in Montreal last week. The other one will be presented to E. F. Campbell, of British Columbia, the first winner of the award. The medal is in the shape of a gold nugget and was donated by Col. Leonard for the best annual paper presented before the Engineering Institute of Canada or the Canadian Institute of Mining and Metallurgy.

HON. WILLIAM C. KENNEDY, who was recently appointed Minister of Railways and Canals in the Dominion Government, was born at Ottawa, Ont., on August 27, 1868. He was educated at Separate School and De La Salle Institute, Toronto.



Mr. Kennedy began his business career in Toronto in 1887 with the London and Canadian Loan & Agency Co., but left in 1897 to engage in the gas & oil business at Windsor, Ont., ultimately becoming president of the Windsor Gas Co. In recognition of his work in the interests of the manufacturers in that district, Mr. Kennedy was appointed president of the Windsor Board of Trade in 1909 and a Trustee of the Windsor Board of Education for 1913-1918. Mr. Kennedy began his political career in 1917, when he was elected to the Federal House of Commons in the Liberal interests, representing North Essex. He was again returned for the same constituency in December, 1921, and shortly afterwards accepted the portfolio of Minister of Railways and Canals.

By the end of 1922 it is hoped that the highway from Pembroke, Ont., to Sault Ste. Marie, Ont., will be completed.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

Alberta, Province of.—The government has been asked to bring down a bill at the next session of the legislature, providing for a bond issue of \$2,250,000, ear-marked for the construction of roads in the province.

Barton, Tp., Ont.—The Township Council decided to macadamize the road on Inverness Ave. Clerk, A. G. E. Bryant, Hamilton.

Beamsville, Ont.—The Town Council decided to have a 4-in. water main in West Ave. and to extend the main in William St. to James St. Clerk, W. D. Fairbrother.

Birch Cliff, Ont.—An Appropriation of \$45,000 for road expenditures was decided upon by Scarboro Township Council. That amount will be used chiefly for gaveling work. Clerk, W. D. Annis, Scarboro.

Bridgeburg, Ont.—The Welland County Council has approved of the project to erect a bridge connecting Fort Erie with Buffalo, either at Ferry St. or a point south of that. The former would cost about \$2,500,000, while the latter would cost \$7,000,000.

Cobourg, Ont.—The Durham and Northumberland Council appropriated \$120,000 for expenditure on county roads this year. Road Superintendent, George Greer, Cobourg.

Galt, Ont.—An announcement was made here recently by N. Asmussen, M.L.A. for North Waterloo, that the Department of Highways intends proceeding with the paving of the Preston-Kitchener road early this spring.

Glencoe, Ont.—The Town Council intends to construct over a mile of concrete sidewalks. Clerk, Charles George.

Gloucester Tp., Ont.—Application for the erection of a new bridge over the C.P.R. tracks may be made to the Railway Commission.

Hamilton, Ont.—A movement is on foot for the construction of a driveway along the waterfront, from Catharine St. east to the intersection at Wentworth and Burlington Streets. The harbor commissioners favor the project.

Hamilton, Ont.—The City Council intends to construct a cement walk on Ottawa St. at a cost of \$1,008.12; cement walk and curb on London St., \$608.40; and cement walk and curb on Burlington St., \$2,416.93. City Clerk, S. H. Kent.

Montreal, Que.—The Board of Control appointed a committee which includes Paul Galibert and Sir Charles Gordon, to take up with the Provincial Legislature the construction of a highway from Bout de l'Isle to St. Anne de Bellevue.

Ontario, Province of.—The importance of the completion at the earliest possible date of the provincial highway between Hamilton and Niagara Falls was urged on Hon. F. C. Biggs, minister of public works and highways, when he recently met representatives of various chambers of commerce in the Niagara district.

Oshawa, Ont.—East Whitby Township Council has set \$6,600 as the amount to be expended on roads and bridges in 1922, which does not include the construction of new bridges and concrete walks. Clerk, P. G. Purves, Columbus, Ont.

Ottawa, Ont.—The City Council granted \$86,000 to the Suburban Roads Commission for this year, \$11,000 for maintenance and \$75,000 for construction work.

Ottawa, Ont.—It is understood that between \$500,000 and \$700,000 will be spent this year on permanent roads in an area within ten miles of the Ottawa city post office.

Ottawa, Ont.—The City Council will apply to the Legislative Assembly for authority to construct an asphalt or asphalt and wood block pavement on Wellington St., between Garland St. and Parkdale Ave.

Ottawa, Ont.—The Board of Control recommended to the City Council that the sum of \$69,000 be granted to the Suburban Roads Commission as the city's share for construction work this year. The city has also been asked to provide \$11,000 for maintenance.

Peterborough, Ont.—The City Council will make an effort to secure from the Dominion Government an additional \$41,666 toward the cost of constructing the Hunter street overhead bridge. On the original cost of \$300,000 for the bridge the Government agreed to contribute one-sixth, or \$50,000, which was subsequently paid. Up to the present time the cost of constructing the bridge has been \$550,000, and the Council will make an effort to obtain one-sixth of this amount from the Government, or a total of \$91,666.

Quebec, Que.—Urging the importance of building a bridge on the Chicoutimi River to connect the northern part of the county of Chicoutimi with the rest of that section, a delegation headed by Mr. Gaudreault, M.L.A., waited on Hon. Antonin Galipeault, Minister of Public Works, and discussed the matter. The cost of the bridge would reach \$600,000. No final decision was reached.

St. Thomas, Ont.—A movement is under way to have work started this year on the proposed Memorial Driveway that was projected three years ago. City Engineer, W. C. Miller.

Sarnia, Ont.—Lambton County Council introduced a by-law to raise \$80,000 for expenditures on the county road system. Road Superintendent, John McCallum, Alvinston.

Stratford, Ont.—The construction of sidewalks on the following streets has been authorized for 1922: Mowat, Albert, Hamilton, Louise, King, Whitelock, Nelson, Gore, Britannia, Mornington, McLagan Drive, Hibernia St., McNab, Downie, St. Vincent, St. David, Birmingham, Douglas, Church and Water St. Also pavements on the following streets: Brunswick, Romeo, Albert, Douro, Church, West Gore, Erie, Water, McNab, Falstaff, Britannia, Cobourg and Hamilton. City Engineer, A. B. Manson.

Toronto, Ont.—The City Council deferred for two weeks final action on the Dundas St. extension to enable an appeal to be heard by the Ontario Railway and Municipal Board.

Toronto, Ont.—The City Council authorized the necessary steps being taken to get approval from the Dominion Government and Ontario Railway and Municipal Board for the plans of the new Gerrard St. bridge over the Don.

Toronto, Ont.—The Board of Control awarded contract for two sand dryers and one asphalt mixer to be placed at the city's asphalt plant, foot of Princess St., to Hetherington & Berner, at \$15,236. Four other tenders were received.

Toronto, Ont.—The Works Committee recommended the adoption of the report of Works Commissioner Harris for the construction of a concrete walk on Glenforest Road, south side, from Boscaille Ave. to Ronan Ave., at a cost of \$4,675.

Toronto, Ont.—The Works Committee recommended the grading of Marigold Ave. at a cost of \$5,276; grading of Larchmount Ave., from Eastern Ave. to Queen St., \$9,893; Berkshire Ave., \$11,168; and Rushbrook Ave., \$9,345.

Toronto, Ont.—At a recent meeting of ratepayers of Roden district, it was suggested that a joint meeting of the City Council, Parks Commissioner and ratepayers be arranged to discuss the building of a subway under the G.T.R. tracks at Ashdale Ave.

Toronto, Ont.—To extend Gerrard St. easterly in straight line from Logan ave. to Pape ave. would cost approximately \$312,000, reports Works Commissioner Harris. To so reconstruct the subway as to straighten Carlaw ave. between a point south and north of Gerrard street would cost approximately \$90,000.

Toronto, Ont.—Application will be made by the city to the Provincial Legislature for authority to pass a by-law to raise \$1,012,579.30 for the construction or renewal of certain pavements in connection with the construction, repair and renewal of the Street Railway tracks of the Toronto Transportation Commission.

Toronto, Ont.—The Works Committee recommended the adoption of the report of Works Commissioner Harris for the construction of pavements on the following streets: Berresford Ave., \$10,179; Boston Ave., \$10,438; Durie St., \$22,277; Evans Ave., \$46,788; Evelyn Ave., \$13,815; Parkview Gardens, \$12,673; Thome Crescent, \$8,065; Woodbine Ave., \$14,610; Hayden St., \$17,283; Lawlor Ave., \$28,367; and lane 1st north of Grenadier Road, \$4,961. Also for the construction of concrete sidewalks on the following streets: Evelyn Ave., Glembeom Ave., Glembeom Blvd., Ladysmith Ave., Milverton Blvd., Strathmore Blvd., Wolverleigh Blvd., Woodington Ave., Woodmount Ave., Berkshire Ave., Eastern Ave. Crescent, Larchmont Ave., Marigold Ave., and Rushbrook Ave., at a total estimated cost of \$63,637.

Victoria, B.C.—Road and trail construction and improvement work has been authorized by the City Council on Hamilton Road, Chester St., Arbutus St., Haultaoin St., Vimy St., and Acton St.

Victoria, B. C.—In order to accommodate the British firm of William Arrol & Co., the Public Works Committee recommended that the time for receiving tenders for the construction of the street railway portion of the Johnson St. bridge be extended from February 13 to February 27.

Welland, Ont.—The Standard Steel Construction Co., of this city, has secured contracts for the construction of three swing bridges, one for the Trent canal, at Hamlet, Ont., and the other two for locks 1 and 2 on the Welland canal at Port Dalhousie, Ont.

WATER, SEWAGE AND REFUSE

Amherstburg, Ont.—Tenders have been received for the construction of a sewer on Alma St. Town Clerk, W. A. McCormick.

Barton Twp., Ont.—The Township Council appointed a committee headed by Reeve Bird to obtain estimates on the cost of installing a water and sewerage system for the mountain district.

Bridgeburg, Ont.—The Town Council passed a by-law for the construction of a sewer to the Amigari section, at a cost of \$40,000. Plans are being prepared by Engineer Ross.

Etobicoke Twp., Ont.—The Township Council intends to pass a by-law to construct a system of water works at a cost of \$4,595. Clerk, Stephen Barratt, Islington, Ont.

Glencoe, Ont.—The Town Council plans the installation of a water works system to provide better fire protection. Clerk, Charles George.

Hamilton, Ont.—The installation of a water meter system has been recommended for the city by City Engineer E. R. Gray, the work of installation to be done gradually. Mr. Gray recommended that \$25,000 be set aside for this purpose.

Hesper, Ont.—The Town Council passed a by-law providing for the borrowing of \$18,000 for water works extensions. Clerk, M. E. Jardine.

Kitchener, Ont.—The Canadian Incinerator & Furnace Co., Ltd., of Toronto, have been awarded a contract to install an additional unit to the city's incinerator. This company erected the incinerator in 1914 and it has been in almost continuous operation since its installation.

Winnipeg, Man.—The City Council intends to construct sewers on Guelph St. and Union Ave., at a total estimated cost of \$3,368. City Clerk, C. J. Brown.

New Toronto, Ont.—A description of the site and the plans of the waterworks intake pipe line proposed to be laid in Lake Ontario at New Toronto have been deposited with the Minister of Public Works at Ottawa.

Ottawa, Ont.—The City Council approved of the laying of a 15-in. and 18-in. tile pipe sewer on Emett St., from Lewis to Lisgar St. Commissioner of Works, A. F. Macallum.

Ottawa, Ont.—The City Council will apply to the Legislative Assembly for authority to borrow \$160,000 for laying an additional line of water pipes in connection with the water supply system.

Peterborough, Ont.—The City Council will build a sewer on Roger St. City Engineer, R. H. Parsons.

Port Credit, Ont.—Reeve R. M. Parkinson announced that the town of Port Credit will have nothing to do with the purchase of water from New Toronto, as suggested by the Ontario Board of Health. He declared that it would be the policy of the council to go ahead with the construction of a separate system.

Stratford, Ont.—City Council authorized the construction of water mains on the following streets this year: St. David, Simcoe, Downie, and Linton. City Engineer, A. B. Manson.

Stratford, Ont.—The City Council authorized the construction of sewers on the following streets this year: McLagan Drive, Simcoe, Nelson, Romeo, Frederick, Dover, Downie, Front, Borden, Norfolk, East Gore, Laurier, Perth, Ross, Whitney, Brant, Guelph and Nile. City Engineer, A. B. Manson.

LIGHT, HEAT AND POWER

Brandon, Man.—The City Council passed a resolution that the Provincial Government be asked to enunciate their policy in the matter of the development of the provincial hydro-electric scheme with a view to the construction of a provincial trunk line to the western part of the province.

Calgary, Alta.—President and Managing Director H. B. Pearson of the local gas company, stated that the company is prepared to expend \$750,000 in drilling new wells next summer for procuring a new supply of gas.

Courtright, Ont.—The ratepayers passed the by-law authorizing the raising of \$11,000 for installing Hydro power. The line will run from Sarnia.

Gloucester Twp., Ont.—The Township Council is considering a project to enter into an arrangement with the Hydro-Electric Power Commission of Ontario for the installation of an electrical system throughout the township.

Halifax, N.S.—It is understood that the Nova Scotia Tramways and Power Co. will purchase from the Nova Scotia Power Commission, at cost, the electrical energy and power up to eighteen million kilowatt hours per year, produced by the hydro development at St. Margaret's Bay, near here. A 30-year contract to this effect has been signed, it is announced. The development has been practically completed by the Power Commission, together with transmission lines to Halifax.

Oakville, Ont.—Residents of the town have formed a company to be known as Oakville Electric, Ltd., with a capital of \$5,000, for the purpose of getting hydro-electric power in the town. President, H. C. Christie.

St. Thomas, Ont.—The gas committee of the City Council has decided to reduce its estimate for the installation of a vertical retort system by \$55,000, making the total amount required \$120,000 instead of \$175,000, as first estimated. The reduction was brought about by a decision to only install one unit this year instead of two.

Toronto, Ont.—The Property Committee approved of a policy of installing 200-watt. nitrogen lamps on a number of business thoroughfares.

Winnipeg, Man.—Joseph Rocchetti, provincial power commissioner, in his annual report urges the extension of power lines to Brandon, Elm Creek, Glenboro, Maniton, Gladstone, Plum Coulee, Morris and Miam.

Winnipeg, Man.—The contract for two 310 k.v.a., 230-

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

A Review of Hydro-Electric Progress in Canada

Progress in Development Last Year Very Satisfactory — 300,000 h. p. Installed in Dominion — Ontario Leads With 177,000 h.p., Quebec Follows With 90,000 h. p. — Queenston-Chippawa Largest Single Development

DURING the year 1921, the re-adjustment of values following war-time inflation, made substantial progress according to a review on Hydro-Electric progress in Canada, prepared by the Dominion Water Power Branch of the Department of the Interior, Ottawa. This readjustment necessarily brought in its train many business and financial difficulties and the lack of confidence in trading circles generally led to a reluctance of capital to embark upon new enterprises. Employment fell off with a corresponding diminution in popular purchasing power and in consequence there has been a general tendency to mark time while re-adjustment advances the further step which will bring costs within the reach of the normal spending power of the community both individual and corporate. The belief seems to be growing, however, that the madir of depression has been passed and that business conditions are improving slowly but surely, and that though 1921 was a bad year for industry it also saw the turning point safely negotiated.

The hydro-electric industry though naturally affected by the general depression suffered no set-back and in fact the horse power installed during 1921, 300,000 h.p., stamps it

That Canada is not lagging in water power development may be shown by comparison with the country most comparable in general conditions, i.e., the United States, thus:

Water Power Development Per Capita

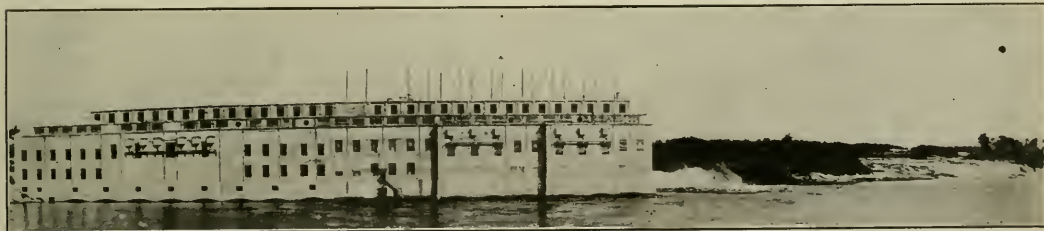
	H. P. installed per 1,000 of population		
	1902	1912	1920
Canada	47	198	280
United States	26	51	93

The total increase in horse power installed from 1900 to 1900 was 153%.

A brief review of development work in the individual provinces and of progress in investigation and plans will give a clearer view of the general situation.

British Columbia

The new construction work in British Columbia in 1921 included that of the British Columbia Electric Railway Co., which commenced the installation of a fourth unit



CITY OF WINNIPEG MUNICIPAL PLANT—POINT DU BOIS, WINNIPEG RIVER. EXTENSION TO POWER HOUSE COMPLETED 1921 (LEFT HAND END)

as one of the most progressive years in Canadian water power history.

The progress of development is somewhat difficult to follow from year to year because the year is too short an interval. From three to five years or even longer often elapses between the first consideration of development and the delivery of power. Again most projects commence with an initial installation much less than the ultimate projected capacity and new units of machinery are installed from time to time as the load develops. In other words, what we may call the scoring column often does not reflect new construction for some years after such construction has been actively underway, but continues to record new scores from old developments.

The 300,000 h.p. installation during 1921 is made up of both kinds of growth and in addition a considerable amount of new construction was initiated which ensures that as old power plants reach their ultimate capacity new ones will take their place in maintaining the continued growth and prosperity of Canadian hydro-electric enterprise.

of 13,200 h.p. at the Stave Falls plant and the Nanaimo Electric Light & Power Co., which placed in operation a 200-h.p. unit in its Coal Creek plant.

Surveys and investigatory work have been carried on for a development on Bridge River, 130 miles from Vancouver, where an ultimate development of 360,000 h.p. is available. The British Columbia and Alberta Power Co., Ltd., has completed plans for the construction of a 6,000 h.p. plant on Bull river in 1922.

Alberta

In Alberta a development of 8,090 to 10,000 h.p. at Lake Minnewanka has been studied and surveyed to supplement the plants of the Calgary Power Co., as further power is urgently required in the city and district.

Manitoba

In Manitoba the City of Winnipeg municipal plant at Point du Bois on the Winnipeg river was increased during 1921 by two units totalling 13,800 h.p. and another unit of 6,900 h.p. is now being installed. This will bring the

total installation up to eleven units aggregating 67,100 h.p. A new duplicate transmission line to the city was also completed.

The developments at Du Bonnet falls (Great Falls) on the Winnipeg river, commenced in 1919 but delayed by



ST. MARGARET'S BAY, N.S. DEVELOPMENT FOR THE SUPPLY OF THE CITY OF HALIFAX AND DISTRICT.

financial conditions, is now financed and under active construction. The undertaking is taken over from the Winnipeg River Power Co. by the Manitoba Power Co., Ltd. The initial installation will be two units totalling 56,000 h.p. and the ultimate, six units totalling 168,000 h.p., at a cost of about \$10,000,000; the initial installation is expected to be completed in 1924.

The City of Winnipeg and District will then be well supplied with power from the three developments i.e., the city's plant, 67,100 h.p., Winnipeg Electric Railway Co.'s plant at Pinawa, 35,600 h.p. and the Du Bonnet plant 56,000 h.p., a total of 160,700 h.p.; in addition to which the developments at Point du Bois and Du Bonnet provide for the installation of further units totalling some 146,500 h.p. First class undeveloped sites on the Winnipeg river will provide for approximately a further 300,000 installed h.p., so that the total power available from this source is some 600,000 h.p.

The Manitoba Power Commission, a provincial organization on similar lines to the Hydro-Electric Power Commission of Ontario, has been active during the past year in extending its transmission system and has now a considerable network. The original line to Portage-la-Prairie, conveying energy purchased in bulk from the city of Winnipeg, has been duplicated and additional lines have been built to Morden, Carmen, Roland, Jordan, etc. Extensions of 150 miles are contemplated during 1922.

Ontario

Construction in the Province of Ontario during the past year has been very considerable. In the same period field investigations and activities leading to future construction have been extensive and there is good prospect of continue construction in the present year.

The Ontario Hydro-Electric Power Commission has continued its activities. Pre-eminent in its construction work of 1921 has been the Queenston-Chippawa project involving an initial installation of five 60,000-h.p. units and an ultimate installation of 600,000 h.p. As is well known this development when completed will be the largest single hydro-electric plant in the world, containing the highest powered units (60,000 h.p.) yet built and setting in several respects new high standards in hydraulic practice. During the month of December water was turned on in the power canal and the first unit placed in operation. The

second unit is ready for practically immediate operation. At the Cameron Falls development on the Nipigon river for the supply of power to Fort William and Port Arthur, this being the second largest generating plant of the Commission, construction of the control dam was completed, thereby permitting the initial installation of 25,000 h.p. operating under the full projected head. Provision has been made at the Cameron Falls plant for a total installation of 75,000 h.p. Work on the 10,000 h.p. development at Ranney's Falls on the Trent river near Campbellford was continued throughout the year.

Private interests have also been active in hydro power construction. The Twin Falls plant, of the Abitibi Power and Paper Co. with a capacity of 24,000 h.p. has been completed, while other new plants completed include the 5,200 h.p. development of the Spanish River Pulp and Paper Co. at Smoky Falls on the Sturgeon river and the 4,500 h.p. development of Canada Cottons, Ltd., at Cornwall. Extensions to existing plants completed during the year include 7,200 h.p. at the plant of the Great Lakes Power Co. at Sault Ste. Marie and 250 h.p. at the Lincoln Paper Mills plant at Merriton and an addition of 4,800 h.p. to the Kenora municipal plant is under construction.

The total turbine capacity installed in Ontario during 1921 amounted to 174,000 h.p. with provision made for extensive additions during the forthcoming year as market conditions demand.

Numerous water power projects are receiving consideration. These have in view additional power supply for the Porcupine mining district; the electrification of the T. & N. O. Railway, and various pulp and paper undertakings.

The proposals for the improvement of navigation and development of power on the St. Lawrence river have been far advanced during the past year. The Board of Engineers appointed by the International Joint Commission to examine the feasibility of the undertaking presented their report last July and this is understood to have been favorable from both the financial and engineering standpoints. In brief, this report suggested four schemes and recommended a combination plan by which the waterway improvement and initial power development of 1,464,000 h.p., in the international section would cost \$252,000,000 and estimated that the power development would pay for the entire project in a comparatively few years. The full potential power development is estimated at 4,100,000 h.p. which could be reached as the market for power developed. Alternative proposals have been submitted by the Hydro-Electric Power Commission of Ontario, by Hugh L. Cooper & Co., of New York, and by the New York and Ontario Power Co. The Commission in a final report dated December 19, 1921, approved of the feasibility and desirability of the general navigation and power scheme but recommended that the engineering details be first passed upon by a Joint Board of Engineers of the two Governments.

Quebec

The activities of the Hydraulic Service of the Department of Lands and Forests and of the Quebec Streams Commission acting for the provincial government, have proved a very real incentive to the increased utilization of the water power resources of the province. Most beneficial work has been done by the Streams Commission in the actual creation of storage reservoirs in several of the principal watersheds. This work has not only proved of great value to the companies developing power on the various rivers so regulated but has also added considerably to the provincial revenues in that the cost is ultimately met by the companies benefited.

Recent operations of the Commission have included the letting of the contract for a storage dam on the Savana river, a tributary of the Ste. Anne de Beaupre. This will provide additional water for the operation of the Laurentian Power Co.'s development at St. Fereol.

Considerable activity took place in water power installation during the year 1921 throughout Quebec province. At Cedars, the Cedars Rapids Manufacturing and

Power Co. had under way the addition of two new units of 10,800 h.p. each, bringing their total installation to 151,200 h.p. This company is also constructing a new transmission line of steel-cored aluminum cable, strung on steel poles, to Montreal, a distance of about 30 miles. At Shawinigan Falls, the Shawinigan Water and Power Co. were preparing to install a new unit in their number two power station of 42,000 h.p. At Grand Mere additional turbine equipment was installed by the Laurentide Power Co. to the extent of 42,000 h.p. The City of Sherbrooke has reconstructed its hydro-electric plant at Weedon on the St. Francis river by increasing the head four feet and adding a new 1,700 h.p. unit, bringing the total installation to 4,650 h.p. At Nicolet Falls on the Nicolet river the Lothbiniere Lumber Co. placed in operation a new installation of 1,680 h.p. The Dominion Textile Co. replaced their old turbines at Magog by a new installation of 3,000 h.p. At St. Raphael on the Riviere du Sud, La Corporation d'Energie De Montmagny placed in operation a new hydro-electric installation of 3,600 h.p. Price Bros. & Co., Ltd., completed their hydro-electric development at Chute aux Galets on the Shesaw river of 17,600 h.p., the power to be transmitted for use in their pulp and paper mills at Kenogami and Jonquiere.

The development work completed in the province of Quebec during 1921 totalled 90,000 installed h.p., with 42,000 h.p. in process of installation. A number of new water power developments were projected during the year

New Brunswick

In New Brunswick an active development policy is being carried on by the province through the New Brunswick Electric Power Commission. Construction has proceeded on the development on the Musquash river, with an installation of 11,000 h.p., for the supply of the cities of St. John and Moncton, and it is expected that power will be available for delivery in the spring of 1922. Contracts are now being negotiated for the annual supply of 15,000,000 k.w.h. to St. John and 5,000,000 k.w.h. to Moncton.

The Bathurst Lumber Co. has had under construction at Grand Falls on the Nepisiguit river a plant of 13,500 h.p. for the operation of their pulp and saw mills and the supply of all commercial needs of the district and the installation of 9,000 h.p. was completed during 1921. The New Brunswick Electric Power Commission have arranged for the purchase of a block of power from the plant and have completed a 33,000 volt transmission line 40 miles long connecting this development with Newcastle and other communities in that district.

The Commission have in view a further development on the Lepreau river to supplement the supply to the cities of St. John, Moncton and districts, and a development on the Tetagouche river for the supply of the North Shore district.

Nova Scotia

The Nova Scotia Power Commission, formed in 1919 under the "Power Commission Act" for the purpose of creating a complete electric power system for the province, has since pursued an enterprising development policy.

The first provincial development, that at St. Margaret's Bay, near Halifax, with an ultimate capacity of 15,000 h.p., is now ready to deliver some 6,600 h.p. (shortly to be increased to 18,000) to Halifax as soon as the contract under negotiation with the city is completed. The re-construction and enlargement of the 800 h.p. plant on Mushamush river for the supply of Mahone, Lunenburg, Riverport, etc., has been completed.

In addition to the above work of the Commission several industrial installations have been made by private concerns. The Yarmouth Light and Power Co. have practically completed the rebuilding of their plant destroyed by fire and an additional 150 h.p. unit is being installed at Messrs. Wright & Jodfrey's plant on the Caspereaue river.

Detailed investigations have been continued for a development with an ultimate capacity of 30,000 h.p. at Sheet Harbor to supply New Glasgow, Stellarton, Trenton, etc., and for two developments of 7,500 h.p. and 1,200 h.p. at

Bear River, to supply Digby and other towns and projected industries.

New Dominion Water Power Regulations

As the fruition of several years of study by the Dominion Water Power Branch of the water power laws and



MUSQUASH RIVER, N.B. DEVELOPMENT FOR SUPPLY OF CITIES OF ST. JOHN AND MONCTON.

regulations of all the principal water power countries of the world, a new set of Regulations for water powers of Western Canada under the jurisdiction of the Dominion Government was completed during the year, under clause 12 of the Dominion Water Power Act. These Regulations were approved by Order-in-Council and were published as a supplement to the Canadian Gazette of Nov. 12, 1921.

Investigation (St. Lawrence River)

Prominent in the investigatory work of the year there must be mentioned that with respect to the St. Lawrence river. That carried out by Messrs. Wooten & Bowden for the International Joint Commission has been mentioned but reference must also be made to the exhaustive work on this matter by the Hydro-Electric Power Commission of Ontario, which started in 1913 and reached its fruition in 1921 by the presentation to the International Joint Commission of three complete alternative schemes for utilizing the full power of the St. Lawrence river.

Co-operative Investigation

The basic investigatory work regarding water power resources carried on by the Dominion Water Power Branch under co-operative agreements with the provinces of Nova Scotia, New Brunswick, Prince Edward Island, Ontario and British Columbia has proceeded with most satisfactory results, and close co-operation and interchange of information has been maintained with the province of Quebec. This co-operation results in better organization and increased uniformity in methods of investigation and especially in the steady growth of the completeness and effectiveness of the Inventory of water power and allied resources throughout the Dominion that is maintained by the Dominion Water Power Branch at Ottawa for the benefit of all interested in water power development.

Stream Measurement

In addition to special investigations of water power resources it is of interest to note that there are now some 750 stream measurement stations regularly maintained on the principal streams from coast to coast, either by the Dominion Water Power Branch or by co-operation between that Branch and the respective provinces. These figures do not include those separately maintained by the province of Quebec.

In Quebec, the Quebec Streams Commission, which

gives its special attention to matters of storage and flood prevention, has continued its highly successful work in the creation of the St. Maurice, St. Francois and Ste. Anne de Beupre reservoirs by studies of the water power possibilities of the St. Maurice, Chamouchaune and Peribonka rivers and the following north shore tributaries of the St. Lawrence, Les Escoumains, Bersimis and Franquelin.

Mackenzie District

Some special investigations were also carried out in 1921 by the Dominion Water Power Branch on the Slave and Hay rivers, which are of interest as being in the neighborhood of the route to the new oil fields at Fort Norman. On the power reach of the Slave river, some 20 miles long between Fitzgerald and Fort Smith, the power capacity is estimated at some 300,000 h.p. and on the Hay river there are two attractive sites estimated at a total of 30,000 h.p., in both cases under ordinary minimum flow conditions.

Relation of Water Power to Coal Consumption

Evidence on the relation of water power to coal consumption was submitted by the Dominion Water Power Branch to the Special Committee of the House of Commons on the Future Fuel Supply of Canada, which sat during the Session of 1921.

It was shown that in Canada there is 194% more water power developed per capita than in the United States and that, in spite of our much colder average climate, the consumption of coal per capita in the United States is greater

In Manitoba the Manitoba Power Commission has extended its activities and the Manitoba Power Co. has under active construction an important development at Great Falls on the Winnipeg river with an ultimate capacity of 163,000 h.p.

The latest figures on the water power resources of the Dominion showing the available water power, the additional installations during the past year and the present total developed power are presented in the appended table.

It will be noted from the table that the developed water power in Canada now totals to 2,756,000 h.p. with considerable activity in the way of new extensions, new construction and projects.

The figures for available power are based upon rapids, falls and power sites of which definite or well established information is to hand. Many feasible power sites are scattered from coast to coast which have not yet been investigated and placed on record. The above figures may therefore be said to represent the minimum power possibilities of the Dominion. As illustrative of the conservative nature of these figures, attention might be called to the provinces of New Brunswick and Nova Scotia where detailed analyses have disclosed most advantageous reservoir facilities for regulating stream flow and where it is estimated that, after providing for the diversity factor between installed power and consumers demands, these two provinces possess within their respective borders, 200,000 and 300,000 commercial horse power.

Province	Turbine Installation in H.P.		Available 24 hr. power at 80% efficiency.		
	On Jan. 1, 1921	Installed during 1921	On Jan. 1, 1922	At Ordinary Minimum Flow	Dependable for six months H.P.
1	4	5	6	2	3
British Columbia	305,115	200	305,315	1,931,142	5,103,460
Alberta	33,187	.....	33,187	475,281	1,137,505
Saskatchewan .....	.....	.....	.....	513,481	1,087,756
Manitoba	83,447	13,800x	97,247	3,270,491	5,769,444
Ontario	1,039,000	173,650	1,212,650	4,950,300	6,808,190
Quebec	926,095	89,290	1,015,385	6,915,244	11,640,052
New Brunswick	21,180	9,000	30,180	50,406	120,807
Nova Scotia	34,073	12,875	46,948	20,751	128,264
Prince Edward Island	1,869	.....	1,869	3,000	5,270
Yukon & N. W. Territories	13,199	.....	13,199	125,220	275,250
	2,457,165	298,815	2,755,980	18,255,316	32,075,998

x Includes two units in the Queenston Plant.

DEVELOPED AND AVAILABLE WATER POWER IN CANADA

than in Canada by 159% in industries, 150% in electric power plants and by 50% in the general average for all uses. At the then price of coal this 50% lower consumption per capita in Canada represents an annual sum of \$146,500,000 that, but for this water power development, would have to be spent on importing coal. The water power now developed is 2,756,000 h.p. and the capital invested therein is about \$534,000,000 so that, from the national point of view, this annual saving represents a return of 27.5% on the investment that has secured it.

General Summary

The more important items of this review of hydro-electric progress in Canada in 1921 may be summarized.

There has been added to the installed capacity of water power plants practically 300,000 h.p. The new installation in the individual provinces has been approximately: Nova Scotia 13,000 h.p., New Brunswick 9,000 h.p., Quebec 90,000 h.p., Ontario 174,000 h.p. and Manitoba 14,000 h.p.

The Power Commissions of Nova Scotia and New Brunswick have successfully carried out the first provincial developments and are practically ready to deliver electrical energy to the principal cities.

In Ontario the Queenston-Chippawa plant of the Hydro-Electric Power Commission of Ontario has been placed in operation with two 60,000 h.p. units installed.

SUGGESTS TWO GROUPS OF RAILWAYS IN CANADA

A RADICAL suggestion for the solution of the Canadian railways problem is offered by William P. Kellett, president of Dominion Steel Products Co., Ltd., Brantford, Ont., and formerly consulting engineer for the Drayton-Ackworth Commission in fixing the value of the Canadian Northern System.

"In view of the critical nature of the railway situation in Canada," said Mr. Kellett, "I suggest that two large organizations be formed to take over present lines in Canada." One system would include the Canadian Pacific, the Intercolonial, and the various lines of the C.P.R. steamships. This system would also include that portion of the Transcontinental line from Winnipeg East. The other system would include the Canadian Northern, Grand Trunk, and the Grand Trunk Pacific from Winnipeg to Prince Rupert, also the Hudson's Bay Railway from Hudson's Bay Junction to Port Nelson.

This plan would divide the railways of Canada into two large competing systems, each of which would have practically equal opportunities in the development of the country, and each of which would share equally the burden of operation of those portions of the railways which have been built, and which are now not sufficiently productive to meet fixed charges and operating expenses.

SCOPE OF THE ENGINEER IN FOREST INDUSTRIES

Large Number of Engineers Employed in Pulp and Paper Industry — Scientific Methods Necessary to Ensure Success in Forest Industries

By S. L. de Carteret

Manager of Lands Department — Brown Corporation

IN choosing the above subject I had in mind the pulp and paper industry in particular, but my remarks will apply equally to that other great user of forest products, namely, the lumber industry. On the basis of value, the exports from Canada in 1921 for pulp, paper, lumber and other wood products stood second on the list, and, if I am not mistaken, the money value of these commodities exceeded \$200,000,000, and constituted approximately 25% of the total export trade.

Referring especially to pulp and paper, Canada has over 100 pulp and paper mills, having a total capacity of about 2,300,000 tons annually. These mills represent a capital investment of more than \$350,000,000 and they employ more than 32,000 persons, in addition to many more thousands engaged in operations in the woods. The province of Quebec has over 45 pulp and paper mills, representing a capital investment of more than \$175,000,000, and whose combined capacity is in the neighborhood of 4,000 tons per day, or over 1,200,000 tons per year, which is about 50% of Canada's entire pulp and paper production.

This, then, is the field. What is the engineer's relation to it? I have an encyclopedia which divides engineering into fourteen branches. Very probably you would not agree with this classification, but the fact remains that at one time or another the pulp and paper industry uses thirteen out of fourteen of the engineers on that list. This is equivalent to saying that the engineer occupies a very important place in the manufacture of pulp and paper; in fact there is probably no industry whose success is more dependent on the engineering profession. As far as the various processes are concerned, while a high state of efficiency has been attained in many directions, other processes must be found or improved for the economic utilization of certain kinds of wood at present considered unsuitable for pulp and paper, and therein is a wide field for the chemical expert.

Must Improve Transportation Methods

Probably the widest field for the engineer today is in improving methods of transporting the raw material from the forest to the mills as it is only in recent years that woodland operations have received due consideration and attention in this country. Formerly it was the general custom to tell the wood boss to cut so many logs in a certain region, and if he got the requisite number at a seemingly reasonable price, the logging operation was considered a success. No attention was paid to the fact that only the best of that timber adjacent to the streams was being cut; that more mature timber was left standing than the amount cut, most of which would eventually be blown down; that waste in high stumps and large tops was equivalent to a large percentage of the timber actually taken; and that the cost of cutting the timber left standing would be all out of proportion with the prices paid for other near timber.

Today the wood using industries realize that their forest capital merits as much care and attention as their other invested capital. Today engineers are employed to survey and map the timber lands in advance of the logging operations. Topographical plans are made which show definitely how best to log and bring out the timber.

Cutting operations are restricted to certain areas and controlled, so that all the merchantable timber which should be removed is taken, and frequent inspections are made to prevent waste from various causes. Storehouses are located where they will serve the greatest territory economically for the longest time, and are built along lines giving promise of minimum upkeep expense, and arranged to expedite taking in and sending out supplies with the least amount of handling. Surveys and plans are made for road

locations previous to construction so that the best possible grades can be obtained and minimum maintenance result.

Better Dams Built Now

Until a few years ago, dams for driving purposes were located and built in a haphazard manner. Such structures located on poor bottom were often washed out by the spring freshets. Frequently dams were built of such dimensions that it was impossible to fill them, while in other cases it was often impossible to discharge the water impounded at a sufficient rate to fulfill the requirements for which they were built, and in some instances dams were carried away because the gates were of insufficient size to carry off the flood waters.

The use of engineering principles now does away with these troubles. The engineer selects a firm foundation where possible, or takes adequate measures to prevent undermining and washouts. He obtains data on precipitation and run-off, measures and calculates the volume of the storage, and then locates and builds a dam of the necessary dimensions to impound the available water, or such portion as is required. He also provides gates of sufficient number and dimensions to discharge the requisite amount of water.

In driving logs and pulpwood the usefulness of the engineer does not end with the construction of driving dams. Other river improvements such as side piers, holding booms, jam piers, &c., claim his attention. There are instances where the supervision of driving by engineers has resulted in the work being accomplished with greater dispatch and at less cost than where ordinary methods of control have been followed. This is particularly true where positive stream regulation is possible, and where, in driving through falls and rapids, the amount of water necessary for an economic driving pitch has been previously ascertained and can be obtained by regulating the flow.

Regulation of Streams

Referring to stream regulation, which is so important in developing the large amount of power required by wood using industries, very few of the rivers in this province are under adequate control. Hence there is an enormous amount of work for the engineer in establishing and operating gauging stations, and in ascertaining the possible storage and regulation of rivers, which, if not at present, will in the future supply the power needed by other pulp and paper mills, and will necessitate the design and construction of permanent dams and regulating works of considerable magnitude.

Water is probably the most useful servant of the wood using industries, as it is the cheapest and most used means of transporting the raw material. However the water-courses designed by nature do not always suit our requirements. They may not run in the direction we desire or they may be too small or too rough to carry the necessary quantities of raw material.

Under such circumstances the engineer must ascertain the possibility of building flumes or sluices to deliver the product at the desired point, and therein he finds ample scope for his ingenuity in locating the best routes and in designing and erecting the most suitable structures to conform to the controlling conditions of the particular problem. The use of flumes often makes it possible to obtain timber which would otherwise be inaccessible. Frequently the use of a flume will increase the annual output of a region several times over that actually possible if the adjacent stream were used, the expense of such transportation, including the original cost of the flume being only a small fraction of the stream driving cost.

In other places a flume may be used to deliver the wood output of several streams to one central point, thereby eliminating separate wood preparing plants on each individual stream. Again flumes may be used to advantage in diverting wood from one watershed to another. This may necessitate pumping the water required, but since a comparatively small quantity of water will carry a large amount of wood in a properly designed flume, the idea is entirely practical. The use of water sluices to load wood

into boats and cars is also a common practice and as this precludes the use of machinery and power with the attendant wear and tear, considerable saving results in operating costs.

These then, are some of the problems which confront the engineer in forest industries. Some of them may not seem of great importance but solving them contributes materially to the success of the various enterprises.

Definition of Engineer

Referring again to my encyclopedia, one definition of an engineer is:

"One versed in or practising any branch of engineering."

Another definition is: "A person who manages skillfully or carries through, any enterprise, by contrivance and effort."

While the first definition is exact, from the professional viewpoint, is not the second worthy of a moment's consideration? Does it not indicate the desire of every engineer, to "manage skillfully" and to "carry through by contrivance and effort."

The successful engineer must, of necessity, be a pioneer, and as such must be determined and resourceful, adapting himself to every inconvenience, and able to find a ready solution to the varied difficulties which crop up in his work. In addition, he must have vision and large ideas, based on sound judgment.

As we look back on the inception and building of the Transcontinental Railway, I am sure that the ten years which many of the engineers spent on reconnaissance and later on construction, in carrying that forerunner of civilization through the wilderness, must be an immense source of satisfaction to them today, especially when they see with their own eyes the villages and industries which have sprung up along the road, and which were made possible by their determination and effort.

And no less must be the gratification of those who went fifty miles further into the wilderness and built the Conlin Dam, creating the second largest artificial reservoir in the world, which, through the additional power obtained, makes itself felt, not only in the plants along the banks of the St. Maurice River, but in the cities of Montreal, Quebec and Sherbrooke.

Similarly in the future, the expansion of forest industries will demand the same pioneering effort on the part of the engineer. Vast areas of forest land, at present inaccessible will have to be brought into close communication with business centers. Railways will have to be built, towns laid out, harbor works constructed, channels dredged, and vessels more suitable for carrying certain forest products, designed and fabricated.

In places where, today, the forest stands untouched, tomorrow the engineer must exercise his skill in planning for the economic utilization of nature's wealth. In doing this he may have to clear a place large enough to pitch his tent; he may be isolated from his kind for many months; but if he "manages skillfully" and "carries through," he will eventually see a silent forest transformed into a scene of keen activity.

His camping place will become a memory only, giving place to monuments of industry where hundreds of souls will make their homes and take their place in the world's work. He will see the rivers performing useful service in transporting raw materials, and in supplying power, light and heat. In short he will see the goods in nature's storehouse co-ordinated and transformed to meet the needs of humanity.

Is this not scope enough for the engineer? Does it not give him ample opportunity to make a permanent record of his labors, and should he not derive great satisfaction in so doing? — Paper read before the Quebec Branch of the Engineering Institute of Canada, Feb. 13, 1922.

The Hamilton Town Planning Board has elected the following officers: Chairman, J. J. Mackay; vice-chairman, John Connon; secretary, Thos. S. Morris.

CAPITAL COST OF EQUIPMENT SHOULD REPRESENT ACTUAL COST

SPEAKING recently before the Electrical Engineering Technical Club in London, Ont., J. E. Pile, of the hydro-electric staff, said. It frequently happens that the equipment originally installed in a station or transmission line has to be removed, either on account of obsolescence or of insufficient capacity. In such case the original amount paid for the equipment, plus cost of engineering, labor and other expenses incidental to the first installation is removed from the capital cost. For instance, if a transformer is removed from a station, all capital invested in that station in respect to the transformer is taken out, thus for the time being, the amount remaining in our records represents the cost of the building and any other equipment that it was not necessary to remove. The value of the replacing equipment can then go back into the station's cost, and our books will reveal the actual amount paid for the building and apparatus as it stands after the change has been made."

The same method is adopted in respect to transmission lines. Expenses of this nature are considered a contingency and are charged against our contingency account. Thus in the balance sheet for 1920 the assets of all the municipalities associated with the hydro-electric system contain the item Total plant, \$27,009,316.65. That sum is actual outlay and has no relation to replacement values of either the buildings or the equipment. The principle adopted by the Hydro-Electric Power Commission of Ontario is that the capital cost as shown in the commission's books must at all times represent the actual cost of the equipment in operation.

LECTURES ON WATER POWER DEVELOPMENT AT UNIVERSITY

A SYMPOSIUM on Water Power Development will be held at the University of Toronto on February 27 to March 6. The course has been arranged by the hydraulic section of the Department of Mechanical Engineering, Toronto University. Lectures will be delivered by Lewis F. Moody of the I. P. Morris Co., T. H. Hogg, and Max V. Sauer of the Hydro-Electric Power Commission of Ontario, Norman R. Gibson of Niagara Falls and Wm. White of the Allis-Chalmers Co. All enquiries regarding the course of lectures should be addressed to Prof. R. W. Angus, University of Toronto.

Pipe-line companies deduct 3 per cent. from the oil gaged to allow for impurities and loss. The fairness of this figure has been questioned, and in order to arrive at a fair basis of deduction upon which to compute the royalties due the Government from operators on public lands, samples of oil from points scattered throughout the Salt Creek field in Wyoming, have been collected by United States Bureau of Mines engineers, and submitted for analysis. Although the results indicated that the deduction of 3 per cent. was large, it has been decided that in fairness to all concerned similar tests of samples should be collected at other seasons of the year and final conclusions be drawn from all the data. The results of this work will be published later.

A record attendance featured the luncheon in the Palm Room of the Chateau Laurier held under the auspices of the Ottawa Branch of the Engineering Institute of Canada, at which the chief speaker was Paymaster Commander W. H. Eves, R.N., who dealt in a graphic manner with the famous battle of Jutland. Commander Eves went through the battle in H.M.S. Royal Oak, and in his capacity as officer in charge of her coding office, he was in intimate touch with the development and progress of the battle. His address was listened to with close attention by the large company present, and was admirably illustrated by large charts showing the various dispositions of the rival fleets. The speaker was accorded an ovation at the close.

BITUMINOUS FOUNDATIONS FOR STREET AND ROAD PAVEMENTS

Rigid and Flexible Types of Pavement Discussed at Length — Cites Cases Where "Black Base" Has Been Used — Advantages of Bituminous Concrete

By Hugh W. Skidmore C.E.

Of the Chicago Paving Laboratory, Inc., Chicago, Ill.

THE TWO most important elements affecting the design of pavements for both city streets and county roads are the character and the intensity of the traffic to be carried. These two factors combine to determine the probable destructiveness of the most potent of all traffic forces, viz: impact. There are other important considerations, such as bearing power of soil, temperature variations, drainage, quality and quantity of local materials, etc., but all of these are of secondary consideration when compared with traffic. The remarkable changes in kind, weight and speed of vehicles which have occurred in the last few years, have necessitated departures not only from some of the accepted practice formulae pertaining to various pavement types, but also from some of the previously conceded standard types of foundation and wearing surface construction.

No One Type Adequately Meets all Conditions

It is ridiculous to assume that any one type of foundation or wearing surface will prove the best under all conditions. In fact, it is very often the case that more than one basic design should be used within a given length of pavement and until this fact is more generally recognized, failures will continue to be more prevalent than they should by reason of the known limitations attending any given basic design.

Two schools of thought, as applied to pavement foundations, have been evolved. These are essentially different in their fundamental principles. One of them seeks to overcome the destructive effect of the traffic loading, which at any instant may be converted into impact of variable intensity and often equivalent to several times the dead load by means of a rigid slab possessing strength superior to the possible force of impact; the other dissipating the blow by absorbing a very considerable portion thereof through a flexible structure, which is always in actual contact with the subgrade, thereby insuring greater uniformity of load distribution and functioning as a distributing medium or foundation and not as a deflector.

Rigid Types of Pavement Discussed

Rigid types, since they must possess strength superior to the traffic forces, have undergone in rapid succession modifications which, with few exceptions, have been of such nature as to increase the original cost of the pavement very substantially. Perhaps the most important reason underlying the necessity of these modifications is the fact that the rigid slab is not at all times in actual contact with the subgrade and, therefore, does not always function as a distributing medium, but must sustain the entire force of the loading within itself. The fact that concrete pavements warp due to temperature stresses, which has been demonstrated by certain investigations of the Illinois State Highway Department, indicates that at almost any time the rigid slab can be expected to be functioning either as an arch with bearing at the outside edges of the slab and free from the subgrade in the central portion, or functioning as a simple cantilever beam, with the fulcrum at or near the crown and with the outside edges not in contact with the subgrade; therefore, the maximum strength of the rigid pavement slab will be demanded when it is acting as a cantilever beam. In view of the data thus far obtained, it is only logical that this idea has been introduced into the design of rigid pavements. It is well known that the internal stresses in pavements, created by changes in temperature, often become very powerful forces and to date the rigid type of construction has failed to offer uniformly satisfactory resistance, as evidenced by cracking.

While it is true that the seriousness of such failures is often reduced by more careful attention to drainage, preparation of subgrade, etc., they are, nevertheless, admittedly inherent weaknesses in this particular type. Soil conditions in certain sections of the country may be such that during a portion of the year the bearing power of the soil will be so low that it cannot be relied upon as offering any very substantial support to the pavement structure. The unstable soil condition may be of limited extent and the soil may be of such character as to admit of ready drainage so that proper attention to this feature will remove the difficulty. Again, unstable soil during a considerable portion of the year may prevail more or less generally throughout certain localities, or the soil may be of such nature that it is practically impossible to adequately drain it even with very elaborate structures. In such cases the construction of sub-foundations may prove a practical solution, while at other times it will be found that a rigid pavement structure will be the most economical. Likewise a combination of subgrade drainage and the construction of artificial subgrade or sub-foundation overlaid by either a rigid or a flexible type of structure will often prove to be the most adequate solution.

It is quite natural that Portland cement concrete and monolithic brick and block pavements, which exemplify rigid construction types, should be passing through the experimental stage in order that they can be studied with respect to their probable ultimate efficiency. Ultimate efficiency, or economy, is of supreme importance and must include not only the original cost, but to this must be added the cost of maintenance and the total spread over a term of years representing the average natural life of the pavement.

Only quite recently have we come into possession of any very definite understanding of some of the forces to which pavements are subjected and as to what limitations appertain to various types with respect to their resistance to such forces. There remains a vast amount of information still to be acquired and investigations which are now in progress will undoubtedly indicate new channels for further study. Some of these investigations now under way deal exclusively with either the rigid or flexible type, while others include both. It has recently been my privilege to observe the work of this nature which is being conducted by the Illinois State Highway Department and to note the very commendable thoroughness with which they are attacking many of the problems surrounding several designs of modern highway construction. There is no doubt but that a fund of very valuable data will result from such impartial, scientific investigations, some of which will apply to all types of pavement construction while some will apply only to such types as are actually under investigation. It is hoped that as results are published from time to time, and the possibilities of further investigation concerning either flexible or rigid types are indicated, that such studies will be immediately undertaken and that this practice will continue until all of the fundamentals underlying both the rigid and flexible types shall have been determined, and it will then be possible to design pavements with a thorough understanding of the limitations and the adaptability attending the use of both.

Flexible Types of Pavements Discussed

Flexible and semi-flexible pavement structures are the oldest types known, and we have only to picture the old Roman roads to realize that the soundness of such construction was thoroughly demonstrated long ago. Although modern traffic requires a wearing surface of superior quality, it is debatable whether highways as they are so often built in this country today, will ever prove as truly economical as they would if we employed more generally the old idea of built-up roadbed, and then laid upon it our modern traffic floor.

Flexible foundations include gravel, broken stone, waterbound macadam, bituminous macadam, and hot-mix bituminous concrete. They are usually classified as to value

in a pavement structure in reverse of the order named, with bituminous concrete as the highest type. It is estimated that there are 15,000,000 square yards of "Black Base" giving satisfactory service in this country.

The bituminous foundation structure although possessing considerable beam strength, functions primarily as a shock reducer, that is, it gives slightly under the blow of impact in transmitting the load to the subgrade. Therefore, the design of this type places considerable reliance in the load supporting power of the subgrade. Its use, then, is dependent upon a knowledge of the ability of the subgrade to support loads equal to the probable force of impact reduced by the slab strength residing in the bituminous structure, whereas the rigid type, regardless of the bearing power of the soil, must be built to sustain the entire force of impact. For this reason a much thicker rigid foundation is required under given traffic and subgrade conditions, as has been demonstrated by impact tests.

It will be readily seen that even where soils are of questionable value as a subgrade, bituminous foundations may still be employed economically if an artificial subgrade of broken stone, gravel, boulders, or even cheaper materials, is first constructed. Where old macadam or gravel roads already exist, an excellent artificial subgrade is offered at almost negligible cost. If widening is necessary, this can usually be accomplished as in the case of the Kingston Pike at Knoxville, Tenn., where "black base" was laid about four inches thick over the old macadam and seven inches thick at the edges of the widened pavement. If time permitted, almost innumerable examples might be cited where "black base" has proven highly economical.

In the West, where the most extensive yardage of bituminous foundation has been laid, the general practice seems to be in taking alternate bids to specify five inches total depth for "black base" pavement and seven inches for Portland cement concrete pavement of 1-2-3 mix. And the general opinion appears to be that the "black base" pavements are giving superior service. Almost universally bids for "black base" pavements have been less than for either Portland cement concrete pavement or asphalt wearing surface on Portland cement concrete base. The saving has varied from 20 to 60 cents per square yard.

Contractors' Views

The opinions of contractors are always necessary and valuable since the very nature of their business requires that they give very careful thought to cost and practical construction features. With this idea in mind I have taken advantage of every opportunity to discuss with them construction problems and costs. In order to obtain an even more representative idea of their experience and views regarding bituminous base, questionnaires were sent to well known concerns throughout the country. Both the number of replies and valuable data contained in them greatly exceeded expectations. The combined activities of the contractors who replied cover every state in the Union as well as parts of Canada and, therefore, can be safely considered as representing the general attitude.

Briefly, the experience of contractors is such that they are willing to guarantee "black base" as readily as Portland cement concrete, and with few exceptions, stated that less risk was attached to "black base." The experience of contractors generally has been decidedly lower maintenance expense and lower first cost except in a very few instances where freight rates proved to be an extraordinary item. Assuming equal depth of foundation, the use of same aggregate materials in both types, and Portland cement concrete not to exceed 1-2-5 in richness of mixture, 90% estimated a difference in initial cost of from nothing to 50 cents per square yard less for "black base," and 75% estimated "black base" at from 25 to 50 cents per square yard less than Portland cement concrete. Since it is true that under similar traffic and subgrade conditions, less depth of "black base" is required, it will be readily seen that rigid foundations will usually cost substantially more than the highest type of flexible base.

One contractor said that during the past 14 years, 85% of the pavements he has laid have been upon flexible foundations, including broken stone, macadam and a goodly yardage of "black base." Certainly this contractor's experience with this type of foundation has proven highly satisfactory.

The only objection raised to "black base" construction by any of the contractors was the possibility of idle equipment in the event a protracted rainy season was encountered on work where the subgrade did not drain readily. Undoubtedly such a combination of circumstances would delay almost any kind of paving construction. However, it is quite probable that it would prove more serious with bituminous work than in the case of rigid base. If it is known that such local conditions as these are at all probable, it would seem that the engineer should provide for such a contingency by specifying an alternative.

The closing paragraph of the Southern contractor's reply seems to typify the attitude indicated by all of them. "Our opinion is that engineers will be performing a useful service in securing the adoption of specifications for black base as an alternate to the use of concrete base."

Conclusion

In summing up the advantages of bituminous concrete foundation it is thought that some of those referred to in previous discussions will bear repetition:

1. Because of greater resistance to impact, permits the use of a thinner base course than is required of the rigid types.
2. Provides uniform contact with the subgrade, thus insuring greater uniformity of load distribution, and precluding the necessity of relying upon the pavement structure to sustain the entire force of the traffic loading.
3. Provides homogeneity of mass and positive bond between wearing course and foundation when bituminous top course is employed.
4. Provides freedom from cracks, upheavals and ruptures which are common to rigid types.
5. Insures against the presence of moisture in the foundation structure, thus prolonging the life of the pavement.
6. Does away with the long period of time required for the curing of Portland cement concrete, thus permitting the opening of completed work to traffic immediately and providing a greater rapidity of turnover to the contractor.
7. Permits the use of the same aggregate materials as are ordinarily employed in Portland cement concrete foundations and provides decided construction economies.
8. Under given conditions, costs substantially less than rigid construction.
9. Maintenance expense is less than for rigid pavements.
10. May be easily repaired at minimum cost, the surface patch method being applicable except in the case of very serious defects.—Paper read before Good Roads Congress of the American Road Builders' Association, at Chicago, January 17, 1922.

As an indication of the contemplated activity in electric light and power plant construction, Dwight P. Robinson & Co., engineers and contractors, of New York and Montreal, have secured important contracts from the Duquesne Light Co. of Pittsburgh and the New Orleans Railway and Light Co. The work for the Duquesne Light Co. includes the installation of the second unit of 60,000 k.w. at the Colfax Power Station, together with three additional substations along the company's lines in the Pittsburgh district. The New Orleans Railway and Light Co. is proceeding with extensive additions to its power plant and distributing systems, including the installation of a 20,000 k.w. turbine and auxiliaries. Dwight P. Robinson & Co. is engaged in preliminary engineering work on several large developments, and reports impending construction activity among public utilities generally.

RAILWAY DEVELOPMENT DURING THE PAST YEAR

Grand Trunk Arbitration and Report of Operation of Canadian National Railways Were Outstanding Events — Lord Shaugnessy's Plan for Operating Systems

PERHAPS the most significant element in the railway situation during the year 1921, according to W. T. Jackman, in "The Monetary Times Annual" for 1922, was the work of the Board of Arbitration to which was entrusted the duty of ascertaining the value of the three preference stocks and the common stock of the Grand Trunk Ry. Co., preparatory to the complete absorption of that railway property in the government system. The appointment of the board was in pursuance of an agreement, dated March 8, 1920, between the Dominion Government and the Grand Trunk Railway Company for the taking over by the Government of the Grand Trunk Railway System through stock ownership.

This agreement provided for the acquisition of the "entire capital stock of the Grand Trunk, except the four per cent. guaranteed stock" amounting to \$12,500,000. In consideration for obtaining control of the Grand Trunk Railway Company of Canada and all its subsidiaries, included in what is called the Grand Trunk Railway System, the Government agreed to guarantee the interest on the existing debenture stocks in accordance with their terms, as follows:

5% Grand Trunk debenture stock	£ 4,270,375
5% Great Western debenture stock	2,723,080
4% Grand Trunk debenture stock	24,624,455
4% Northern debenture stock	308,215
Total	£31,926,125

In addition, the Government agreed to issue new stock of the Grand Trunk Railway Company of the par value of \$12,500,000, with a guarantee by the Government at four per cent. annual dividend thereon, in exchange for the then outstanding issue of four per cent. stock of the same par value, guaranteed by the Grand Trunk Railway Company, which was non-cumulative but prior in its claim on earnings to the preferred and common stock. The voting powers possessed by the debenture and guaranteed stocks were to cease, and all voting powers were to vest in the preference and common stocks.

The agreement provided also that the first preference (5%) stock amounting in par value to £3,420,000, the second preference (5%) stock amounting to £2,530,000, the third preference (4%) stock amounting in par value to £23,955,437, should be taken over by the Government at a £7,168,055, and the common stock amounting in par value to valuation to be determined by a board of arbitration, and in exchange for these stocks the Government should issue "new guaranteed stock," bearing four per cent interest, equal in amount to the arbitration value of the preference and common stocks.

Grand Trunk Arbitration

For determining the value of these stocks, therefore, there was constituted the board of arbitration, with Sir Thomas White representing the Government, Chief Justice Taft of the United States Supreme Court representing the railway company, and Sir Walter Cassels, Judge of the Exchequer Court of Canada, as the chairman. In the autumn of 1920 the arbitrators were taken over the main lines of the Grand Trunk and Grand Trunk Pacific and on February 1, 1921, they began the taking of evidence. The board was to fix the value of these stocks as of May, 1920, and its report was expected to be ready by April 9, 1921, nine months after its appointment. The proceedings before the board dragged on slowly, in spite of the intimation to the company that the time for the arbitration would not be extended except upon terms of immediate possession and control of the railway system of the Government.

It was considered by the Government that certain shareholders and others in England were showing their resentment at the taking of the property from them and

were endeavoring to give the impression that the Government was dealing harshly with the company. The Grand Trunk directors denied any attempt to block or impede the Government's work. The Government, on the contrary, declared that since public funds were being used to finance the railway operation it was unreasonable for the company to retain possession of the property. However, a Bill was later introduced into Parliament providing that, upon condition that the company should agree by May 16, 1921, to hand over complete control of the property to the Government, the arbitration would be revived. This was made effective; the arbitration was continued, and on September 7, 1921, the reports of the arbitrators were submitted to the Government.

The Board's Award

The chairman of the board and the Government representative on the board agreed in the award that "there is no value in any of the four classes of stocks." The important facts leading to this decision may be briefly outlined:

1. The manipulation of the accounts of the company, which rendered the books unreliable. This was done at the instigation of the chairman of the directorate in London, who preferred to pay dividends, even though they were not earned, rather than face an awkward situation by telling the stockholders the truth.

2. The draining of the company's earnings to pay dividends rather than using these earnings to provide for the maintenance of the property and facilities in the most efficient operating condition.

3. The admission of the President of the railway company to the Railway Inquiry Commission of 1916, that, if left to itself, the Grand Trunk must suffer a crash, and both it and the Grand Trunk Pacific would have to go into insolvency if the present Grand Trunk had to carry out its obligation in regard to the Grand Trunk Pacific.

4. The enormous amount owing to the Government by the Grand Trunk on behalf of the Grand Trunk Pacific for capital for construction, for the payment of fixed charges and operating expenses, and for the expenses of the receivership.

5. That the value of the stock should be determined on the basis of the net earnings, actual or potential, of the company; and since the Grand Trunk System, as a system or group of interrelated and interdependent companies, has no net earnings (but rather a deficit) and is not likely to have a surplus of earnings for many years, the stock cannot have any investment value.

Minority Dissented

The company's representative on the arbitration board, Chief Justice Taft, dissented from the majority for the following reasons:

1. From the evidence of eminent railway engineers and managers, there seems no reason to doubt that the roadway and the equipment is in good condition for operation and this is proved by its success in handling a heavy volume of traffic, and in carrying the immense business thrust upon it during the war without a break. (He regarded the testimony of the men whom the Department of Railways and Canals had sent out to report upon the road and its deficiencies as an "enthusiasm of condemnation" that injured the weight of their evidence.)

2. The other two arbitrators refused to allow the admission of any evidence regarding the reproduction cost of the railway or the value of the physical assets. But Chief Justice Taft considered it perfectly relevant to the problem in hand to receive evidence both as to the reproduction value of the railway system and as to the physical value of the property as distinguished from the reproduction value. Such evidence is held in the United States as appropriate in judging what a railway company should earn and thereon in fixing rates. With conditions so much the same in two countries, and especially since the Grand Trunk railways are affected directly by the rates in the United States, it would seem proper to adopt the same rule of evidence.

3. In the arbitration of the value of the Canadian

Northern stock, in a similar proceeding in 1917, presided over by the Chief Justice of Ontario, evidence was received as to the reproduction value and this was used in making the award. If that evidence was relevant in the Canadian Northern case is it not also relevant in the Grand Trunk case? If such evidence had been admitted in this instance, it might have affected very materially the opinion of the board regarding the earning capacity of the road and its future possibilities, especially in view of the fact that in the United States the tendency is to make the reproduction value of railroad property used economically for transportation a proper basis for fixing rates.

4. Because the earning capacity of the company in May, 1920, was low — when the nadir of railroad prosperity in the world had been reached — or because the company was almost in a state of bankruptcy, is no reason for saying that the interests of its shareholders was worth nothing. Who can say what would have happened to the Grand Trunk if the Government had not taken it over? Perhaps the bondholders, who come to its rescue in 1860, might have come to its aid again and tided it over till the return of normal conditions.

5. On the basis of the past earnings and probable future earnings (concerning which statistics are given), there is every reason to believe that within five years the conditions of the company would be so much improved that it would have some leeway for making capital expenditure to improve the property without excluding the shareholders from participating in the benefit of better times.

Appeal to Privy Council

So far as the award is concerned the majority ruling is accepted, but it is of little consequence. The Grand Trunk has appealed its case to the Privy Council in England, and that tribunal has always been much more favorably disposed to guard the interests of property. If it should admit evidence concerning the replacement value of the Grand Trunk System — and from its past decisions there seems to be good reason for anticipating that it will — it is almost indubitable that the railway shareholders' claims will be adjudged fairly large, probably larger than the maximum amount which the Senate fixed as compensation for these four stocks, namely, \$64,166,666.66.

To one who looks with impartiality upon the results of the arbitration in the cases of the Canadian Northern and the Grand Trunk stocks there is something avowedly antagonistic to any sense of justice. In the former, the stockholders of the \$60,000,000 of common stock had never put a dollar into the property and yet this stock, which had been shown by the Railway Inquiry Commission of 1916-17 to represent "no cash investment," and to have "no present value," either on the basis of reproduction cost or earning power, was awarded a value of \$10,800,000 by the board of arbitrators; whereas the stocks of the Grand Trunk which are the subject of this arbitration, amounting to over \$37,000,000, or roughly \$180,000,000, all of which was "fully paid up in cash," were declared by the majority of this board of arbitration to be valueless.

Is the Award Unfair,

It is possible that in the case of the Canadian Northern there were interests which the Government did not want to see exposed to loss on account of unsatisfactory financing, while in the case of the Grand Trunk there were no friends at court to safeguard the interests of those who had invested their money in the enterprise? I merely suggest this question, and there are those who know well the answer. Moreover, is there any justice in admitting as evidence in the case of the Canadian Northern the reproduction value of the property, and using this in arriving at a decision concerning the value of the stock, whereas in the similar case of the Grand Trunk stock such evidence is refused by another board of arbitrators? Again we ask, Was there a method in this madness. If the boasted advantages of arbitration as a means of settling justly such a very important problem as the value of a great railway system can be upheld by such discriminatory application of the principle

as that manifested in these two cases, it is not a principle which can command the confidence of judicious and fair-minded people.

The National Railways

The second important feature in the railway interests of Canada during the year just closed was the annual report made by the Minister of Railways and Canals to Parliament in March, 1921. The deficit of the government railways, which in 1919 amounted to almost \$50,000,000, was shown to have increased in 1920 to about \$70,000,000. These figures do not include interest on the capital of the National Transcontinental and the Intercolonial railways; but as the capital for these lines was furnished by the government of the country, and interest on this capital, under a strict accounting, would be paid by one branch of the government to another, we may neglect this portion of the deficit.

An increase in the railway deficit of almost 50% within one year calls for explanation and is the occasion for a serious consideration of railway affairs. The announcement of such a result by the Minister of Railways and Canals created a sensation in Parliament and throughout the country, which has brought the railway problem into the forefront of national issues. The demand on the part of the Parliament and the public for a thorough investigation of the affairs of the government railways so as to make public the essential information by which to judge as to the administration of these railways, was met by the appointment of a committee of inquiry of the House of Commons on Canadian National Railways and Shipping.

Committee of Parliament

This committee, composed of members of the three parties in the House, were strictly limited in its functions. Its first and most important duty being to determine what information concerning these governmental agencies could be given with propriety to the public. Information was obtained by the committee as to the increased cost of operation, attendant upon the very high wages and high cost of materials, the method of letting contracts, the system of auditing, etc. The committee recommended that it should be reappointed early in the next session of Parliament to complete its inquiry, but until it should be able to give more careful consideration to the railway issues and to obtain further knowledge it did "not feel disposed" — to make definite reply" to the questions referred to it. Neither this committee nor the Government had any definite plan for dealing with the railway problem; the Government simply allowed the matter to drift on and passed an appropriation of \$165,000,000 for the year 1921.

But there are others who have been thinking about the remedies for the serious condition of the publicly-owned railways and two of these are men who stand high in the railway and industrial world. Because of the wide attention which has been attracted by their public statements, it is important that the letter should be considered here.

Lord Shaughnessy's Advice

Lord Shaughnessy, chairman of the Canadian Pacific directorate, sent to Premier Meighen a letter, dated April 6, but not made public until April 24, in which he reviewed the history and present conditions of the railways, and set forth his plan for relieving the people "from some part of the distressing and dangerous financial results now in evidence and which threaten the future." Briefly, his policy was to leave the Grand Trunk System under private ownership and operation and to bring promptly and effectively to the aid of the National Railway System additional financial strength and sustenance by having the national railways merged with the Canadian Pacific for operation and management.

He would have all the extraneous assets of the Canadian Pacific (including its ownership of railways in the United States, its ocean steamships, its land still owned, etc.) segregated from the company's Canadian system of railways, vessels, and other accessories and this latter would be joined with the national railways under the comprehensive organization of the Canadian Pacific for administra-

tion and operation. In consideration for the Canadian Pacific shareholders giving up their interest in the return from the extraneous assets, which would then be under separate management, the Government would enter into a contract approaching perpetuity with the Canadian Pacific by which the company would operate the whole property for account of the Canadian people. The Government would agree to pay the shareholders in perpetuity a fixed annual dividend on the share capital, to be supplemented by a further payment when the whole property was yielding a specified return.

By having these properties all operated by the one management, there would be so many economies effected that the operating ratio would be reduced from about 101% to a maximum of 80%, which would reduce the total annual deficit to eleven or twelve million dollars. Gradually even this would be overcome through settlement of the country and increase in traffic; and in the meantime the saving to the country would be very large. There is no question whatever that the plan outlined by this great railway statesman would be of inestimable benefit, in overcoming the financial handicap of the national railways and providing the country with transportation facilities in the management of which there would be shown enterprise, initiative and a constructive national outlook. If this plan were accepted the details would have to be worked out carefully; but thus far the Government has shown no inclination to depart from its present policy of drifting and piling up of deficits. The report of the Railway Inquiry Commission had shown some of the advantages from consolidation of railways, and this plan developed by the former President of the Canadian Pacific was simply carrying out the principle of consolidation to its logical conclusion, under the most hopeful conditions for imminent success.

It is worth noting here that the scheme devised and put into operation in England for readjusting the railway relations since the period of government control has been abandoned involves the creation of four large systems, each with a complete monopoly in its own territory. Evidently, then, monopoly does not have the same terror for the English people as it has for some craven-hearted parliamentarians and newspaper editors in this country, who are vociferous in their denunciations of a railway monopoly and equally clamorous in proclaiming the supposed virtues of public ownership.

Sir Joseph Flavelle's Recommendations

The other public man whose contribution upon the railway problem has been sent to the Government is Sir Joseph Flavelle, who during recent months has been the temporary chairman of the Committee of Management of the National Railways. After reviewing some aspects of the railway history he showed the financial necessities of the National System, involving capital expenditures in the immediate future amounting from \$125,000,000 to \$175,000,000, which will constitute a new fixed charge of \$10,000,000 per annum in addition to the present fixed charges. (This is in great contrast to the entire fixed charges of the Canadian Pacific Railway which stand at \$15,910,516.) Moreover, the operating loss for the year 1921, estimated by that of the first six months of the year, will exceed the governmental estimate. He emphasized the urgency of keeping politics out of the management, the necessity of the people using their own road, the importance of a well developed settlement policy for the unoccupied lands of the West, as well as for those lands contiguous to the railways; and while acknowledging that economies would result from the complete integration of all the components of the National System, he was careful to warn against the belief that these economies would be immediately reflected in reduced operating charges.

His calculations showed that the Government System, when fully completed by the inclusion of the Grand Trunk lines, would have net fixed charges aggregating \$66,000,000 per year. His plan for meeting the situation so as to relieve the railway company — "the Dominion Treasury cannot be

relieved except through increased earnings" — is as follows:

That the new National Railway Company should have a nominal authorized capital stock of \$750,000,000, consisting of \$500,000,000 of common stock and \$250,000,000 of preference (6%) stock; and that the Government take common shares at par in payment of its existing advances to the various systems. These advances on December 31, 1920, amounted to \$320,000,000 of loans and \$33,000,000 of Grand Trunk Pacific debentures. The cost of the Intercolonial and National Transcontinental railways should be written off at once. For the future, any expenditure that should properly be charged to capital should be provided by the Government and for these advances from year to year the Government should receive preference stock at par. All deficits which the Government had to meet should be settled by giving to the Government common stock at par. The company would then issue preference stock only against capital expenditure advanced by the Government, and the common stock would be issued to the Government in payment of its advances to meet operating deficits, including fixed charges. In this way the common stock would represent the cost of acquiring the system plus the amount of the operating deficits from year to year, and the preference stock would represent the amount of capital expenditure made by the Government upon the railway system after its unification. Of course, the obligations of the railway company to the outside public would be represented by the bonds, debentures and guaranteed stock outstanding.

Of the many criticisms of this plan which suggest themselves to the thinking mind, I shall mention but one, namely, if, as Sir Joseph states, "the annual deficits in operation and fixed charges are an actual and irrecoverable loss, and should not be carried as an active debit against the railway," why not honestly though sorrowfully charge them off as losses instead of using them to swell the capital stock account of the Government? If they are losses that are irrecoverable, they can never be transformed by any accounting device into capital in the hope that some dim and distant day in the future the company will be able to pay dividends upon them.

In this contribution to the railway problem by one who has been a very successful business man and who has rendered distinguished service to his country, we find too many "ifs" and other conditional statements to give any comfort to the supporters of the policy of public ownership. Indeed, that does not seem to have been the primary purpose in its writing, but rather to tell the truth about the railways, no matter how harsh the truth may be.

BILL INTRODUCED IN FAVOR OF ST. LAWRENCE PROJECT

ACCEPTANCE by Congress of the report of the International Joint Commission on the Great Lakes-St. Lawrence Waterway is proposed in a bill introduced by Representative Mapes, who proposes that the commission's recommendation be adopted by Congress, subject to such further diplomatic negotiations between the United States and Canada, and such action by the appropriate legislative bodies of the two Governments, as may be necessary.

The measure also would authorize and require the President to enter into negotiations with Canada for the purpose of establishing an International Board of Engineers to work out and report within the year detailed plans and specifications for the construction, operation and control of the waterways. The United States and Canada would have equal representation on the board and would share expenses equally.

Canalization of the St. Lawrence River will not only be a great international asset commercially, but will also promote already friendly relations between United States and Canada, declared John A. Russell, president of Detroit Board of Commerce, speaking to the Windsor, Ont., Chamber of Commerce.

COMMODITY PRICES APPROACHING NORMAL LEVEL

COMMODITY prices on the average are apparently approaching a normal level after war-time inflation and the consequent deflation of 1921. This is shown by the accompanying chart supplied to "The Canadian Engineer" through the courtesy of Dwight P. Robinson & Co., engineers and contractors of New York and Montreal. The price chart which covers the period 1860-1922 and all commodities, has been plotted from official figures from the United States Bureau of Labor. The dotted line drawn from 1896 through 1914 charts, shows the gradual rise in prices following the panic of 1893 and indicates gradually improved standards of living and wage conditions.

This price movement, which was entirely normal, would doubtless have continued if the war had not intervened. Therefore, in seeking to determine a normal price level, it is more logical to base considerations on the prolongation of this 1896-1914 line rather than on the average for 1914, which is shown on the chart to be 100. The dotted line reached 115 in 1922; therefore the price index of 149 for January 1 for all commodities is only 34 points above the level which might have been normal but for the war. Considering economic conditions throughout the world, this increase is not considered so unreasonable.

Substantial price decreases from the peak of 1920 took place in 1921 in almost indirect ratio to the percentage in which the ratio of the gold reserve has been increased by

The index figures for lumber and building materials in December 1920 was 266, and for the period from April to December, 1921, was as follows: 203, 202, 202, 200, 198, 193, 192, 197, 203. This seems to indicate a fairly stabilized condition. If demand during 1922 continues to be strong, it is doubtful if appreciably greater reductions will take place.

Referring to the chart it will be noticed that during the period May 1920 to July 1921, deflation was consistent and rapid, and a drop of 124 points from the peak was registered. The turning point came in August and from then on the detail of the curve was as follows: August 1, 148; September 1, 151; October 1, 152; November 1, 150; December 1, 149; January 1, 149.

MAY EXTEND TORONTO SUBURBAN AREA

A PROPOSAL to extend the suburban area of Toronto will shortly come before the Ontario Railway and Municipal Board, if the plan as now designed receives the approval of the city council. The city assessment department, under T. D. LeMay, has been working under the suburban area legislation received by the city since 1912, and the time has arrived when it is considered that an amendment to the area plan must be made in order to attain the desired results. The area in which the city has been working comprises the territory within a five-mile radius of the

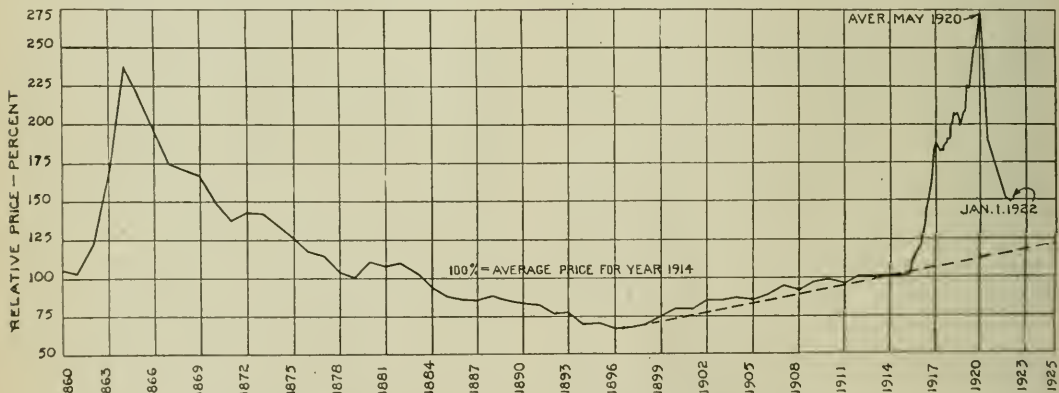


CHART SHOWING RELATIVE PRICES OF COMMODITIES FROM 1860 to 1922

the recall of federal reserve notes. According to a recent Federal Reserve System statement this gold ratio increased from 54.8 per cent. to 105.5 per cent. in 1921, probably indicating complete deflation in the currency. Prices of several classes of commodities which fell rapidly during 1921 have now apparently become somewhat stabilized. For instance, the price index for lumber and building materials on January 1 showed an increase of 6 points over the figures for December 1, thereby registering the second increase in 14 months. This rise in the index is undoubtedly the result of the steady demand for building materials indicated by the latest construction reports available for 1921, which show a total volume only slightly below 1919.

The similarity between the price curves for the two war periods is strikingly shown by the chart, the upward trends in each case being almost exactly alike. Price conditions during and following the Civil War were entirely the result of the business and financial situation in North America, while the recent inflation and subsequent deflation resulting from the Great War were general with few exceptions throughout the world.

The index figure for metals and metal products in December, 1920, was 157, and for the last three months of 1921, October, November and December, was 121, 119, 119.

city limits. The proposed plan would be square, instead of circular; its outlines being farther removed from the city limits in order to embrace territory not at present included either in the city zone or that of any of the urban municipalities, which, under the act, may control the area within three miles of their borders, where it is not part of the larger zone connected with the city.

Power has been turned on at the Grand du Bonnet power plant which will enable the work of construction to make better progress.

Premier Drury has promised the Ontario Housing and Town Planning Association that a committee of the Legislature will be appointed to codify laws relating to city planning in Ontario, and to suggest such amendments as may be necessary to give municipal town planning boards sufficient powers under the direction of municipal councils. The premier is also considering a request that \$2,000,000 of federal funds for housing loans be applied for at an early date. It is understood, however, that the premier is not favorable to further provincial participation in civic housing.

RECONSTRUCTION AND RESURFACING OF OLD PAVEMENTS

Brooklyn Adopted Recut Block Method of Granite Pavement Construction and Heater Method of Asphalt Resurfacing — Extracts from Specification

By J. Schmitt

Bureau of Highways, Brooklyn, N.Y.

NOT many years ago the determination of the necessity for repaving a street was a simple matter. A pavement was either serviceable or it was worn out and required replacing. An asphalt pavement whose surface had become uneven, or whose maintenance costs were prohibitive, was removed and replaced with new. A granite pavement which had become unduly rough through wear, was removed and a new pavement substituted. Modern traffic, however, has introduced a condition under which a pavement may be entirely unsatisfactory without being near the end of its life. Such is the case when granite blocks have become worn to a degree of roundness on top as to cause undue noise and vibrating under heavy traffic, and in the case of asphalt when irregularities or waves have reached the point of causing similar vibration and discomfort to occupants of vehicles. Complaints in increasing number are heard from residents, of the annoyance and damage caused by vibration transmitted to buildings from pavements of irregular surface under heavy traffic. Building improvements on a street are frequently of mixed character, or are undergoing change from residence to business, residence to factory, and the like. In many cases the type of pavement suits the average condition, but minority interests also demand consideration.

To remedy the condition arising from the use of a pavement of suitable character, but of indifferent state of repair, though not worn out, the recut block method of granite pavement reconstruction was adopted in Brooklyn and the heater method of asphalt resurfacing. These utilize the material at hand to a great extent, requiring relatively small additional quantities of paving materials; they produce a surface comparing in every respect with a new pavement; and they do this at a much reduced cost as compared with the price of a new pavement.

Granite Pavement Reconstruction

In repaving a granite paved street, the old material, where discarded, has but little salvage value to the community, because of the uncertain market for second-hand paving blocks. Contractors can afford to make but little difference for such blocks and in consequence the community bears in full the value of the new blocks required. Why, therefore, should not the market for the old blocks be made on the job?

The blocks on many streets requiring reconstruction are of the old type, large size, 10 to 15 in. long, 3½ to 5 in. wide, and 7 to 8 in. deep. The size in use today is 8 to 12 in. long, 3½ to 4½ in. wide, and 5 in. deep. The cubic content of the old type block is practically double that of the newer type, so that two blocks can be produced from one. This is therefore done by splitting the old block through its centre and redressing the resultant two blocks. The heart of the old block becomes the head of the new. In many cases it is not possible to obtain two blocks from one, owing to defects in the old stone, but the percentage of blocks suitable to produce two recut blocks is generally sufficient to overcome the loss in recutting and rejects. Experience has proven that the gain and loss practically balance. As a rule there is a small surplus of blocks and in only a few cases has there been a deficiency. The only difference made in the size of block from current specifications (Brooklyn) for improved granite block is that the minimum of block allowed is 6 in., as against 8 in. for new blocks, with a minimum width of 3¼ in. as against 3½ inches.

These blocks are laid to the same specification requirements as for new blocks, with ½ in. maximum joint and 1 in. cushion, and bituminous or grout joint filler. The

concrete foundation is built up by a full 3 in., the difference between the old 7½ in. block on 1½ in. cushion and the recut 5 in. block on 1 in. cushion. The following is an extract from specifications for this class of work:

"When the use of blocks recut from old granite blocks is permitted under the contract, such blocks shall comply with the specifications for quality as required for new blocks, and be of the following dimensions: not less than 6 in. nor more than 10 in. long on top; not less than 3½ in. nor more than 4½ in. wide on top, and not less than 4¾ in. nor more than 5¾ in. deep. The recut blocks shall be dressed in the manner specified for new blocks; the sides and ends shall be sufficiently smooth to permit of the blocks being laid with joints not exceeding ½ in. in width at the top and for 1 in. downward therefrom, and not exceeding 1 inch at any other part of the joint. The blocks shall be cut so that the faces will be approximately rectangular in shape. The top surface of the block shall be cut so that there will be no depression measuring more than 3/8 in. from a straight edge laid in any direction on the top and parallel with the general surface thereof."

Of this type of reconstruction pavement there had been laid in Brooklyn N. Y., approximately 4,000 sq. yds. in 1919, 11,000 sq. yds. in 1920, 48,000 sq. yds. in 1921, with 62,000 sq. yds. now in progress on under contract. The recutting of the blocks costs about \$30 per thousand against a price on the work for new blocks of \$130. This difference is partially counterbalanced by the average size of the blocks, which run about 40 to the square yard, against 28 for new blocks. In September, 1921, bids were taken for new and recut granite pavements, the new being priced at \$5.25 per sq. yd. for pavement only, as against \$2.77 for recut blocks.

The results obtained have been entirely satisfactory and the saving in cost substantial. While old pavements may be so worn as to be useless for recutting, the method offers a practical solution of the problem of salvaging granite pavements which are worn but not worn out.

Asphalt Resurfacing

The Borough of Brooklyn, N.Y., with its 11,000,000 sq. yds. of asphalt pavement, has experienced the difficulty of keeping such pavements in repair to a greater extent than most municipalities. The older pavements were laid without the careful attention to formula now given, with the result that much creeping and pushing of these pavements occur under modern heavy traffic. Though far from worn out, their surface may be distinctly irregular and wavy. The asphalt may have in it years of life, but be in such condition as to surface that a general overhauling is necessary. This is accomplished by the heater method of resurfacing. The surface of the pavement is heated to a temperature such that about ½ in. of its surface is softened and can be scraped off. A layer of new asphalt surface mixed is spread upon the heated surface and rolled and finished in the same manner as surface otherwise laid. If properly applied, this method produces an excellent bond. Many test cuts have indicated perfect adhesion of the new asphalt to the old, and the maintenance costs on resurfaced streets compare favorably with new full depth pavements. The heater used is designed to soften the pavement by hot air blast, the flame not being permitted to impinge on the surface. The new layer is laid to an average thickness of one inch. In preparation of the work before applying the heater, all excessive waves or hummocks are removed by cutting down to the foundation. The asphalt used is similar in formula to that employed on heavy traffic streets, its composition being as follows:

Passing 8-Mesh sieve, retained by 10-mesh sieve—	0% to 5%
" 8-mesh " " " 40-mesh " "	—25% to 45%
" 40-mesh " " " 80-mesh " "	—20% to 55%
" 80-mesh " " " 200-mesh " "	—10% to 30%
" 200-mesh " " "	—13% to 20%
Bitumen—	9.5% to 12.5%
Penetration of A. C.—	35 to 45."

Should the old material be of doubtful stability, the use of the surfacing of stiff mixture serves as a protective coat and minimizes the creeping of the pavement.

This method has been used with success on streets of moderately heavy traffic, but its field lies chiefly in the improvement of pavements subjected to average traffic of residential sections and secondary arteries.

The following extracts from specification for such work are submitted:

"The repaving or resurfacing of the asphalt shall be done by process or method of heating and removing the surface of the old pavement by means of a properly constructed surface heater. The essential feature of this heater shall be that no flame comes directly in touch with the surface to be heated or softened. Its general construction shall be such as will admit of heated air being blown upon the surface of the old pavement to be removed, thereby heating and softening it so that all inert, disintegrated, worthless, and uneven or irregular surface material can be easily removed by means of hoes, rakes, or other appliances.

The contractor shall use proper guards to prevent the heat from cracking or injuring the curb, headers, or other structures along the line of work. He shall prevent the heat emitted from the stack from injuring trees or shrubs.

Where excessive waves or hummocks exist along headers and around manholes or wear holes, the contractor will be required to remove the old material by cutting to the foundation, where directed by the engineer and replacing it entirely with new material.

The surface of the old material must be clean, soft, and hot at the time that new material is laid thereon. Should the surface become chilled, hardened, or dirty, it must be reheated and again cleaned before new material is applied.

After the surface of the old material has been properly prepared, a coating of new material shall be laid thereon to such a thickness as to give when rolled, a layer of new material over the old not less than $\frac{3}{4}$ of an inch in thickness and averaging as nearly as possible one inch in depth, after rolling."

In the Borough of Brooklyn 50,000 to 100,000 sq. yds. per year of heater resurfacing has been carried out for some years past with entirely satisfactory results.

The price in September, 1921, was \$1.09 per cu. ft. of wearing surface mixture of \$1.68 per sq. yd. This compared with a price for asphalt only laid on the old foundation of \$2.25, including removal of the old pavement. In September, 1920, the price was \$1.43 per cu. ft. or \$2.03 per sq. yd. comparing with a price of \$3.65 for specification asphalt. The price of resurfacing, therefore, ranges from 60 to 70 per cent of new asphalt, exclusive each of foundation.

This method is believed to be the most practical for salvaging the useful part of an old asphalt pavement. The material requiring handling is reduced to a minimum; the work is performed expeditiously and with the least possible inconvenience to residents on the street. Various methods of re-employing old asphalt in the preparation of a new mixture have been tried with varying success. The heater method, however, has been successfully used for years, and while the saving effected is less than in the case of the recutting of granite blocks, it is substantial and is supplemented by the comfort to residents in having a repavement started and finished the same day.

Representatives of over seventy municipalities held a meeting in Toronto on February 16 to register a protest against the Provincial Government interfering with the hydro-radials. A vote of confidence in Sir Adam Beck and his work was passed.

It is reported that the Canadian members of the International Joint Commission will tender their resignations on account of the change of government at Ottawa. The commission consists of C. A. Magrath, chairman, Sir William Hearst and H. A. Powell.

DILUTION IN THE TREATMENT OF SEWAGE

By Peter Gillespie

Prof. Civil Engineering, Faculty of Applied Science, Toronto University

THE function of dissolved oxygen in a stream or other body of water is in the conversion of organic matter into stable and inoffensive forms. Fresh water when saturated with oxygen, contains at freezing temperature about 6 grains of this element per cubic foot, decreasing to about two-thirds of that amount at summer temperatures. Such oxygen is abstracted partially or completely from the stream into which organic matter in the form of sewage is discharged, the abstracted oxygen being necessary in the processes of wet combustion which proceed in the stream. It has been figured that a million gallons of average American sewage requires for its oxidation about 1000 lb. of oxygen. The resulting depletion of the oxygen content of the stream is often readily apparent.

When the content falls below 70% of saturation, major fish life disappears and when 30% of saturation is reached a condition approaching a nuisance especially in hot weather is the result. Put in another way, a stream flow of 2 cubic feet of water per second per thousand of the population will be the very minimum for the prevention of offensive conditions. Since, however, it is undesirable that most of the oxygen be abstracted from the stream and since also, thorough dispersion of the filth throughout the water is never attainable, a stream flow of 4 or perhaps 6 cubic feet per second per 1000 of the contributing population is much more likely to result in the absence of nuisance. Such a stream will obviously lose much of its natural attractiveness.

The speaker described the methods of bacteriological examination of waters and the significance of the presence of the colon bacillus, qualitatively and quantitatively. If this organism be present in large numbers, sewage contamination is likely to be recent and in relatively large quantity. The possible presence of pathogenic bacteria is also thereby indicated.

The tentative standards for sewage effluents of the Royal Commission on Sewage Disposal in which the maximum permissible amount of suspended matter contained was specified, as were also the more recent ones of the International Joint Commission on the Pollution of Boundary Waters for the Detroit and Niagara Rivers. The 500 B. Coll per 100 c.c. standard suggested by the latter Commission is a moderate maximum in comparison with what some water filters in America are obliged to cope with. The self purifying capacity of large bodies of water is shown in that while the pollution of Lake Ontario at the mouth of the Niagara River is very great, at a distance of 18 miles lakeward from this point, it disappears practically altogether judged by the non-occurrence there of the colon bacillus. The purifying power of nature assisted by time, accomplishes here what human agencies and human resources find it impossible to duplicate.

In reference to the complete purification of sewage before discharge into a stream as against the purification of the public water supplies drawn therefrom, Mr. Hazen was quoted to the effect that it is unmistakably better to purify the waters taken from the rivers than to purify the sewage before it is discharged into them. In the first place it is cheaper since the cost of purifying 1,000,000 gallons of water is less than the cost of purifying the same quantity of sewage. In the second place it is more effective since few plants treat all the sewage from the districts which they serve.

The speaker reviewed American and Europe practice in respect to sewage disposal as exemplified in half a dozen typical plants and the reason for the selection of the special feature in each. Dyckman Street Station, Manhattan, with fine screens only; the Enscher Valley with sedimentation only; Atlanta, Ga. with screens, sedimenta-

tion and percolating filters; Trenton, N. J. where sedimentation only for the present is proposed; Worcester, Mass., with sedimentation and sand filters; and Brampton, Ontario, with its activated sludge were among those described.

In conclusion, the speaker enunciated these five principles as indicating the trend of practice today in the art of sewage treatment:—

1. Streams are at once the drainage channels and the sources of public water supply of a country.
2. No sewage should be discharged into a stream without some measure of treatment; no public water supply should be taken out without some measure of treatment.
3. Complete purification of sewage is less effective and more costly than a partial purification of the sewage followed by a purification of all water supplies.
4. A wise policy is the design of a plant anticipates the growth of the future and provides for it.
5. Dilution is one of the oldest as well as the most modern of methods. From a paper read before the Peterborough branch of the Engineering Institute of Canada.

Boving & Co., Ltd., London, England, have recently been awarded a contract by the Government of New Zealand for water turbines in connection with the Mangahao hydro-electric power scheme. The order includes the supply of five main Pelton wheels—three, each having a maximum output of over \$8,000 brake h.p., and two, each over 4,000 brake h.p.; also two smaller exciter Peltons, each 325 brake h.p. The wheels will work under an average head of water of 825 ft.

The election of officers of the Engineers' Club, Toronto, took place last week and the following were elected: J. B. Carswell, president; W. R. McRae, first vice-president; E. G. Hewson, second vice-president; A. B. Cooper, third vice-president; Directors, J. C. Armer, F. R. Ewart, C. H. Heys, A. H. Hull, T. D. LeMay, Balmer Neilly, Geo. G. Powell, A. V. Trimble, W. F. Wright, E. W. Wright, T. S. Young; Secretary-Treasurer, R. B. Wolsey. The report presented showed a satisfactory year's operations, and a substantial balance to the credit of the club.

MASONRY WAS REPAIRED BY CEMENT-GUN

LAST year the Public Utilities Commission of the town of Napanee, Ont., instructed their engineers, Messrs. James, Proctor & Redfern, Toronto, to prepare a report and tenders on repairing the headrace and canal, which supplies the water to the town, for developing the power to run the water works system and furniture factory.



REINFORCEMENT IN PLACE AND GUN OPERATOR AT WORK

This canal, which is approximately 1,000 ft. long, is constructed of masonry and was built some thirty years ago. Its condition became such that the embankment was



SHOWING CONDITION OF MASONRY BEFORE REPAIRS WERE MADE

in danger, and a leakage was causing trouble in the loss of head.

The engineers, knowing what had been done by "Gunite" in repairing such walls as Governor's Island sea wall, New York; the sea wall at Bridgeport, Conn.; masonry bridge arches at Lancaster, Pa.; masonry in Chicago Drainage Canal; Grand Trunk Railway bridge piers at Weston, Ont.; masonry sewers at Dayton, Ohio, etc., as well as many



SECTION OF COMPLETED CANAL

dams, reservoirs and ditches, placed a contract with the Gunite Co. of Canada, Ltd., Hamilton, Ont., to carry out this work.

Specifications called for the walls to be built up to the original shapes, the masonry cleaned by sand blast or wire brushes and a reinforcement of 2-in. hexagonal mesh 14 gauge or equivalent, to be fastened in place; a coating of "gunite" 2 in. thick of a mixture of one part cement to three parts sand, to be then applied. This coating was carried up the face of the walls, over the top and down the back for 12 in. The actual working time was fifteen days, and a type N-1 Cement-Gun operated by a Chicago Pneumatic portable compressor was used on the work.

Government consideration of the report of the Joint International Waterways Commission on the proposed deep water route from the Atlantic to the Great Lakes will probably be given between now and the opening of parliament.

EXPERIMENTS ON AIR-LIFT PUMPING

Details of Experiments Conducted at St. Domingo, Portugal
— Causes of Loss in Efficiency — Advantages of Air-
lift Pumps — Discussion on Dr. Owens's Paper

IN a paper read before the British Association of Edinburgh, Dr. J. S. Owens, B.A., briefly described his paper on Air-lift Pumping, in which he dealt with the possibilities of the air-lift pump rather than indicated any final conclusions as to the best design of such pumps.

The results of past experience had shown that the air lift was usually an extremely wasteful method of pumping, owing to its low efficiency, but it appeared that if this low efficiency could be overcome, there would be an immense field for the use of the air lift pump.

The experiments described were made with a view to ascertaining the most efficient design for an air lift pump, for lifting acid mine liquors in the mine of San Domingo, in the South of Portugal. With the installation finally adopted, tests showed that it was quite possible to get pump efficiencies with air lifts of between 60 and 70 per cent.

A study of the work already done on air lift pumping had convinced Dr. Owens that the low efficiencies usually obtained — it would appear that to expect an efficiency of 45 per cent. from an air lift pump was regarded as optimistic — were not an essential part of the method. The causes of loss in these pumps might be grouped under the following heads:

- (1) Slippage losses, due to relative motion between air bubbles and water.
- (2) Losses due to friction of the mixture of air and water in the rising main.
- (3) Friction losses incurred by the flow of water before air is admitted.
- (4) Energy discharged in the kinetic form with the water, and due to the velocity of discharge.

Cause of Losses

The losses under the last two headings were definite quantities, and might be said to be more or less under control; it was in connection with (1) and (2) that there appeared to be good opportunities for increased economy. From experiments made on the question of submergence, it had been definitely established that there was a most suitable value for this, the best efficiency being obtained with a submergence of about 70 per cent. of the total length of the pipe—submergence plus lift. The point to be kept in mind was simply that the relation of submergence to lift had an important bearing on the efficiency, and in some of the author's experiments it was seen that an appreciable effect was obtained by even small variations in submergence.

The theoretical aspect of the losses due to the four heads mentioned was briefly dealt with, and experiments which were carried out to examine the relation of diameter of bubble to velocity of rise through the water, and the conditions governing the size of the bubbles, were described, it being now generally accepted that the air lift depends for its operation upon the fact that a mixture of air bubbles and water is lighter than pure water. So far as slippage losses are concerned, a high velocity of the mixture tends towards a low slippage loss. From the results of tests on friction, the author had calculated the coefficient of friction and obtained a value of 0.025 in a 6% in. pipe with a mean 13.3. In this case, however, friction losses included all losses except slippage losses, friction losses before the water arrived at the footpiece, and losses in kinetic energy of discharge. As to this latter, it was well known that a fair amount of energy might be lost by delivering the water at too high a velocity, but this was easy to avoid, by using a conical or trumpet-shaped expanding mouthpiece to the delivery pipe.

The paper then described the air lift pump at San Domingo, already referred to. The installation is in two lifts. The bottom or No. 2 lift, raises the water from the 210 m. to the 180 m. floor, where the discharge from lift No. 2 is received in a large tank or pool, which pool forms

the inlet to lift No. 1. The latter raises the water from the 180 m. to the 150 m. floor. There is no submerged pipe, such as is used in tube wells, but the inlet pipe is carried down a shaft in the form of a U-tube, the air admission foot-piece being fixed a little above the head at the bottom of the U on the eduction pipe. This has the same effect as submergence, although to travel down the descending lift of the U. All pipes are lined with lead, and the air is made of lead, since the liquor is of a very corrosive nature, and rapidly attacks cast iron. The No. 2 lift was put in early in 1920, as an experiment, with the intention of completing the installation by adding the No. 1 lift if it proved a success. The result of the tests made after the installation showed an efficiency of over 60 per cent. for the experimental pump, which was considered to justify after adding the second lift.

Dealing with the advantages of the air lift over other methods of pumping for this type of work, provided a reasonably good efficiency could be obtained, the author said that there need be no machinery underground nor need any machinery be exposed to the acid liquors. The amount of attention and repairs required for an air lift were negligible, as compared with other pumps, such as, for example, ram pumps. At San Domingo a three-throw electrically-driven ram pump was displaced by the air lift. The electric pump was a continual source of trouble, and required great attention to keep in order, as pump and motor had to be fixed in a chamber in the mine, and were constantly exposed to drips of acid liquor. In designing the air lift pump, the main objects aimed at were to provide a smooth, unobstructed flow of water through the pipes, avoiding any method of introducing air which interfered with this object; to keep the bubbles of air in the eduction pipe as small as possible; by the use of a Venturi throat at the air admission footpiece to arrange for uniformity of pressure at the top and bottom of the throat piece, so that the air distribution could be controlled; to avoid a sudden increase of velocity at the footpiece, and to bring about the necessary change of velocity in the water resulting from the admission of air as gradually as possible.

An illustration of the footpiece showed that the air was admitted into an annular chamber surrounding a Venturi throatpiece, the latter being perforated with a number of holes of $\frac{1}{8}$ in. diameter, starting from the narrowest part of the throat. The diameter at the throat was such that the loss of head due to the velocity at the throat would somewhat more than balance the static head due to the increased depth at the throat. The length of the throatpiece was fixed so that the angle of opening of the trumpet-shaped upper part should not exceed 5 deg. The holes were distributed in rings around the throatpiece, the number per ring gradually increasing towards the top, so that as the air was added to the water, and the velocity thereby increased, the rate of increase would be such that the velocity head would vary uniformly. From 550 to 600 holes were used. The footpiece was of cast iron lead lines, and designed to simplify the changing of the throatpiece, so that different forms could be experimented with. The supply of compressed air was from the air line supplying the mine, and no special compressor was required. The air was at 80 lb. per sq. in., and this determined the maximum submergence possible to use.

The results of the tests showed that the efficiency of No. 1, or upper lift, varied between 56.6 per cent. and 61.13 per cent., while the efficiency of No. 2 varied between 52.5 per cent. and 66.1 per cent. The conditions under which the tests were made were varied, with the object of ascertaining the best form of throatpiece, and the tests were made with three different forms of throatpiece, varying in diameter at the throat between 3.25 in. and 4.59 in. The throatpiece with the smallest diameter gave the highest efficiency. A further pair of throatpieces were now being experimented with, in which the diameter of the narrowest part was 2½ in. The discharge ends of the eduction pipes were enlarged by a taper piece up to 18 in. diameter, in order to minimize the loss in kinetic energy of the water. In some tests the footpiece was fixed so that the centre of the air inlet pipe was 3 ft. above the

top of the bend in the water pipe, but this was found insufficient, as there was a great tendency for the air to blow back round the bend and momentarily reverse the action of the pump. The foot piece, therefore, was lifted to 12 ft. above the bend, and this was found effective in preventing such blow backs.

The operation of starting the pump might be divided into stages, as follows: (1) Compressed air is admitted to air pump until head of water is just balanced; the air pipe is then full of air to footpiece, but no air has yet entered rising mains; (2) the water in the rising mains is at rest. Air is admitted to rising main, but as there is no water current to carry it away, it probably collects in large plugs or one large plug above footpiece, displacing the water until the latter reaches the top and overflows; (3) when the water overflows at the top, the pressure on the column of air is relieved and it expands, causing a greater overflow, and if the plug of air is at the bottom of the rising main, or anywhere well below the top, as the column of water is removed it tends to expand with explosive violence; (4) the relief of pressure on the rising main is so rapid that it cannot be compensated for by flow in at the bottom, and therefore, the pressure in the air pipe will fall, to recover gradually as the rising main fills from below; (5) during stage 4, when water is flowing past the footpiece, the air has a chance of mixing with the water, and, if enough air is then admitted, continuous flow will result. If, however, insufficient air is admitted, it may be sufficient only to keep the water near the level of delivery without overflowing. This method of starting appeared to be almost an essential under the particular conditions.

The advisability of admitting the air where the velocity is highest, i.e., at the narrowest part of the throat, is now being tried, but it is questionable whether other drawbacks will not neutralize any advantage thus gained. The expedient of using an eduction pipe of gradually increasing diameter from the footpiece to delivery is useful if it could be applied, so that the velocity of the mixture is kept uniform instead of increasing, as it must do in a cylindrical pipe, owing to the expansion of air. There is, however, great difficulty in applying it practically, where conical pipes are very costly, and instead of a gradual change of diameter it is usually enlarged in steps, with consequent loss at each step. It seems doubtful, said the author, if there is much advantage to be gained in this way over a short, trumpet shaped or conical delivery end with sides at 5 deg. or less.

Discussion on Air-lift Pumps

The chairman referring to air lift pumps said that Mr. A. W. Purchas, in a paper published some time ago, had stated that the theory on which the air lift pump should be designed was the displacement theory. Mr. Purchas had assumed that the operation of the air lift pump was due to the formation of a fairly large bubble, which rose to the top and displaced the water; this bubble was followed at some distance by another large bubble. He did not think the pump worked under the most efficient conditions when the rising main was filled with a mixture of small bubbles and water. He (the chairman) could not believe that.

Dealing with Dr. Owen's paper, Prof. Lea said that the air lift pump had great advantage, because all the machinery could be installed on the surface. Centrifugal pumps, for instance, had a lift of not more than 25 ft., and when a lift of 100 ft. was desired, a centrifugal pump would have to be installed in a wall near the surface to be lifted. In certain cases either air lift or reciprocating pumps were essential. He would like the author to give figures of efficiency of air lift and reciprocating pumps, taking into account the cost of air compressors and everything else. Probably with long continuous working one would not get more than, perhaps, 50 per cent. efficiency with an air lift pump, whereas high lift reciprocating pumps might show an efficiency of over 80 per cent.

Dr. Owens, in reply, said he had tried to agree with Mr. Purchas's displacement theory, but had been unsuccessful. It was quite certain, from his experience of the

air lift pump he had described, that the discharge from the air lift, when working properly, was a mixture of small bubbles and water. As a matter of fact, he was of the opinion that the description in Mr. Purchas's paper indicated that his efficiency was due to small bubbles. Regarding the general utility of air lift pumps, in the particular case dealt with, he had calculated that if the air lift gave an efficiency of 40 per cent. it would cut out the existing arrangements; actually, he was getting an efficiency of 60 per cent. With careful design, one could calculate on getting an efficiency of well over 60 per cent. Previously the electric pump had been installed in a little cell hewn out of the rock at a depth of about 150 m., and there was a constant rain of acid from the roof, which was extremely corrosive; even monel metal was dissolved like sugar. Under such conditions as he had described the air lift pump was most useful.—From a paper read before the British Association at Edinburgh.

U. S. SENATE ISSUES REPORT APPROVING ST. LAWRENCE WATERWAY

A REPORT has been issued by the United States Senate, under the title "Extract from the Report of the International Joint Commission concerning the improvement of the St. Lawrence River for navigation and power." Part 6 of the document contains the conclusions and recommendations of the International Joint Commission. "An analysis of the testimony submitted makes it clear" says the opening paragraph, "that the consensus of opinion in the two countries, as revealed at the public hearings, while far from unanimous, was on the whole distinctly favorable to the proposed improvement of the St. Lawrence. Broadly speaking, it may be said that public sentiment throughout the middle western and western states from Ohio to Idaho, was almost unreservedly in favor of the deep waterway." The only evidence submitted on behalf of the Mississippi Valley was also favorable. Various organizations and the individuals in the Eastern States expressed themselves as approving of the project. On the other hand, evidence was not wanting of a widespread sentiment in some of the Eastern States antagonistic to the project. On the Canadian side, anything like general approval of the undertaking was confined to the province of Ontario. In the other provinces public sentiment appeared to be either indifferent or more or less hostile.

Alternative Routes

"In the first place it appeared at the hearings that many Canadians were pre-occupied with the merits of alternative routes to the seaboard. This was particularly noticeable in the western provinces, where keen interest was expressed in the possibilities of the Hudson Bay route, to which the Dominion Government had more or less committed itself some years ago, and upon which it has already expended over \$20,000,000 and expects to spend another \$17,000,000. In the east a similar sentiment was found in Montreal and North Bay favorable to the proposed Georgian Bay route, which has been before the Canadian people for many decades.

"The opposition to the suggested improvement centred largely in the State of New York, but was also supported by representatives of various public bodies in New England and in some of the Atlantic coast points south of New York, as well as in the city of Montreal. The commission is satisfied that many of those who have opposed the project did so because they were convinced that it was impracticable and not in the public interest. It is equally satisfied, however, that much of the opposition had its source in what might be called local patriotism. That is to say, that many citizens of Buffalo, Montreal, New York, Albany, Boston and Philadelphia were determined to oppose the project mainly because they believed that it would adversely affect the interests of Buffalo or Albany, or the New York barge canal, or of the great seaports of New York, Philadelphia, Montreal and Boston. In the other hand, the de-

mand for the waterway comes from the area which is most vitally concerned in the opening up of a new transportation route to the seaboard.

Navigation Problems

"The commission believes, from the evidence before it, that ocean-going ships of suitable draft would find no serious difficulty in navigating the deepened St. Lawrence. The physical obstacles which, in the opinion of opponents of the undertaking, would make the proposed waterway impracticable, are its long, restricted and tortuous channels of insufficient depth, fog and ice conditions, time loss and damage sustained in getting through locks, and the limited navigation season. The commission's conclusion that these physical obstacles would not be sufficient to deter ocean-going ships from coming up into the lakes is based, among other things, on the two unquestioned facts that for many years past ocean-going ships have successfully navigated the St. Lawrence for a distance of approximately 1,000 miles, and that at the same time the big lake freighters have successfully navigated the Great Lakes and their connecting channels."

The report discusses the project from the economic and the engineering point of view and, in harmony with its conclusions, recommends that the Governments of the United States and Canada enter into an arrangement by way of treaty for a scheme of improvement of the St. Lawrence river between Montreal and Lake Ontario; and that the new Welland Canal be embodied in the said scheme and treated as a part thereof.

MOTIVE POWER FROM SEWAGE

ACCORDING to the London Times Engineering Supplement experiments in the utilization of sewage gas for the production of motive power are being made at Cole Hall, Birmingham, by J. D. Watson, the engineer of the Birmingham Tame and Rea District Drainage Board. The plant is designed to give 25 b.h.p. for a working period of six hours a day, and includes a 34 b.p. (maximum) horizontal gas engine of the ordinary suction type. The exhaust pipes from the engine are enlarged to 9 in. diameter and made to pass through the digestion or generating tanks with the object of imparting heat to the sludge, and so promoting fermentation. Two analyses of the gas, carried out in September and in the present month, showed 77 and 67.5 per cent. of methane, with 3.2 and 4.2 per cent. of hydrogen, the calorific value in the two cases being 700 and 650 B.Th.U. In describing the plant before a meeting of the Institute of Municipal and County Engineers at Birmingham, Mr. Watson estimated that the employment of the gas, instead of the ordinary suction gas plant that was originally proposed, means a saving of £29 10s. annually. The sludge at Cole Hall is bought by farmers for agricultural purposes, and so long as it can be got rid of in this satisfactory way there is no need to employ intensive fermentation. Only the sludge required to give off gas for power will therefore be subjected to fermentation, and from the limited experience at present available it is estimated that about two tons of wet sludge (10 per cent. dry solid matter) will be required to provide an explosive gas capable of generating 25 b.h.p. for a working period of six hours a day.

The Annual Convention of the American Association of Port Authorities will be held in Toronto, September 14, 15 and 16, 1922

At the Pittsburgh Experiment Station, in connection with the investigation of coal-storage problems, coal has been exposed to excess air for three hours at 150 degrees Cent.; the amount of oxidation products formed and the amount of oxygen absorbed are taken as a measure of the tendency of the coal to ignite spontaneously. The method has been tested on Newfield (Freeport) coal and Texas lignite with fairly consistent results.

Letter to the Editor

PUBLICITY FOR ENGINEERS

Sir: On page 188 of your January 31 issue, there is the following paragraph:

"There was considerable discussion regarding publicity for engineers in connection with a motion introduced by C. A. Mullen, but no suggestions of any value were forthcoming and the discussion was finally closed by Mr. Acres with the assertion that publicity will follow meritorious work without solicitation, and that if every engineer will do his work to the very best of his ability and do it faithfully and well, recognition and publicity and remuneration will follow as surely as night follows day."

It seems to me that this paragraph loses something by it not being stated therein that Mr. Blanchard of Niagara Falls was the seconder, and that the project had been discussed in the morning, and strongly supported by no less prominent a member than R. A. Ross, president of the Institute for 1920.

As far as I recollect, the only one who spoke against publicity for the engineer was Mr. Acres, and he is the only one whom you have quoted, though you were present both at the morning and afternoon sessions.

Mr. Ross remarked: "Something that Mr. Mullen has said has stirred me up. Nothing is ever done in this wicked world without propaganda. The thing for us to do is to get propaganda—absolute propaganda. Advertise ourselves and pay for it. That is the only way you can get it, and the question is whether the Council would not be well advised during the year to consider this matter very carefully."

Then Mr. Ross went on to state that we would shortly see initiated a campaign of publicity for a permanent "Research Institute" at Ottawa, for, said he, the Honorary Advisory Council for Scientific and Industrial Research had decided that a permanent "Research Institute" much broader in its scope than the present Advisory Council was necessary, and that they were going to get it for Canada by convincing the Canadian people who have the votes that parliament should enact a measure establishing such an Institute.

I do not see how you can countenance, without adverse comment, such a statement as that the doing of engineering work well will bring its own recognition and remuneration. Some of the most valued members of our profession get very little of either; while I, possibly, get more of both than I deserve. At present, I suppose, I have to find ways and means of advertising myself, without seeming to do so; I would far rather help advertise my profession, wisely and openly.

I am afraid that you have a wrong impression of what I mean by publicity for the engineer; it certainly has no relation to town-boasting campaigns or the work of commercial manufacturers' associations. What I do think is that the average man, and very many of the business men, do not know what engineering means to the community; very few even know the danger of proceeding with investigations and work without first submitting their propositions to engineering criticism. Much money is lost to the community in this way; and, in my humble opinion, most of our social evils are due to the fact that our political state is run by what we call political lawyers instead of by engineers.

Down with the Political Lawyers. All power to the Engineers.

CHARLES A. MULLEN,

Consulting Paving Engineer.

Montreal, Que., February 8, 1922.

The Canadian Engineer

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LESSONS FROM THE KNICKERBOCKER THEATRE DISASTER

OUT of the confusion and conflict of evidence that usually attend any important engineering failure, it is difficult to formulate causes, more particularly if one is not in possession of first-hand information. However, with the report of the admirable investigation of the collapse of the Knickerbocker Theatre, Washington, Jan. 28, made by Engineering-News Record before us, we believe that certain general observations concerning this lamentable disaster, in which nearly 100 people lost their lives, may safely be made.

It appears that the structural steel framework supporting the roof, imperfect in design and detail though it may have been in some particulars, would in itself not have brought about failure. The assemblage of beams, trusses and columns would, according to our present information, have borne safely the design loads or the loads existing on the roof at the time, at substantially the assumed factor of safety. The supporting walls were able to support the applied loads, for in spite of the rough usage which they must have sustained in the collapse of the roof, they stood practically undamaged after the accident. There must, then, have been some source of weakness between raming and walls, if either was able to support the loads and with the combined action of the two elements, the roof fell. This inference, together with certain features of behavior of the roof in falling, gathered from markings and scorings on the truss seats, led the author of the report mentioned to conclude that the collapse originated in the dropping of the wall end of the principal truss in the ruff off its bearing on the wall, this circumstance entailing the fall of several auxiliary trusses and the other dependent construction.

Support is lent to this theory by the further fact that the trusses merely rested on these seats and were not bolted or otherwise fastened to them. There was consequently lacking what should be regarded as fundamental by all constructors of buildings — a secure tie between steel framing and the supporting walls. Without it, the cumulative effects of temperature and vibration may bring about, as they apparently did in the Knickerbocker theatre, a fatal horizontal separation of superstructure and supports.

A circumstance which prompts Engineering News-Record to some guarded speculation is the fact that the suspected end of the main truss rested at a sharp skew on a curved tile wall 18 in. thick and 35 ft. high to the bottom chord of roof trusses. Question is raised as to the effect of this skew and also of the deflection of the truss on a support of its kind. A field of study is no doubt opened up here. Some twenty years ago, startling things were found out concerning the weakness of skew arches, through the failure of an important arch in Australia, and it may chance that the effect of distortion in a pronounced skew construction may be to produce an unexpectedly heavy dragging effect on the supports. Further, the horizontal concavity of the wall with respect to the supported main truss in itself merits investigation. Unquestionably, a wall of such a shape in plan tends to yield more readily towards the outside than would one convex toward the interior of the building. Its action would be similar to that of a concrete dam arched downstream, as against one arched upstream. The fact that the curved wall now leans 5 in. into the street throws suspicion on the sufficiency of rigidity of this wall to maintain itself in position under the truss and beam loads.

A SERVICE TO THE ESTIMATOR

VALUABLE assistance has been afforded the estimator through the commendable investigation of prices of construction as determined by materials and common labor made recently by "Engineering News-Record." Everyone who has attempted to make use of cost data given in published articles and in handbooks has found it difficult heretofore to adjust the costs so given to suit existing conditions. Through the application of the "Engineering News-Record," construction cost index it should be a comparatively simple matter where the date of the original construction is given to render the data so furnished of value as a present guide.

It is of interest to note that the average cost index for the year 1921 is given as 201.78 based upon an Index of 100 for the year 1913, and that this index figure was 167.82 for December, 1921. While a substantial drop has occurred from the average of 1920, which was 251.28, we have still a long way to go on this continent to reach the pre-war level. That we are heading downward in construction costs is strikingly evident from the fact that while at the beginning of 1919 the price average of twelve representative construction materials was 69% above the general average of spring prices from 1913 to 1918 inclusive, at the beginning of 1921 the average had fallen to 31%, and at the end of 1921 it was only 2% above the chief average of spring prices for the nine years 1913 to 1921. While these figures were established for conditions in the United States, they apply fairly closely to Canada.

PERSONALS

J. J. McKAY has been elected chairman of the Hamilton, Ont., Town Planning Board for 1922.

CAMILLE LAURENDEAU, B.A.Sc., graduate of Laval University, son of Judge Laurendeau, of Montreal, has joined the sales staff of the MacKinnon Steel Co., Ltd., with office at 404 New Birks Building, Montreal.

COL. A. MacDONNELL and GENERAL J. STEWART, of Grant, Smith & Co., & McDonnell, Ltd., contractors of Vancouver, B.C., sailed from New York last Wednesday for England. They will visit the Gold Coast in connection

with an important contract which they have received from the British Government for constructing docks, breakwater and railway.

PAUL LECLAIRE has been appointed assistant chief engineer of the Port of Montreal. Mr. Leclaire was born in Montreal in 1881. He graduated from Laval Polytechnic School in 1901 and in 1911 was appointed engineer in charge of buildings, bridges and water supply to the Harbor Commission. Mr. Leclaire has also been engaged in engineering work in Pittsburgh, with the C.P.R. and the Dominion Bridge Co.

MICHAEL P. FENNELL, JR., secretary-treasurer of the Montreal Harbor Commission, has been appointed general manager, a newly-created office. Mr. Fennell, who is a native of Montreal, graduated from McGill University in 1903. He has been connected with the port for several years, first as secretary to Sir John Kennedy, then Robert McKay, and afterwards George W. Stephens. In 1917 he was appointed secretary-treasurer, which post he has filled with conspicuous success until the present time.

G. C. OMMANY has been appointed development engineer of the Development Branch, C.P.R. Department of Colonization, with headquarters at Montreal. Mr. Ommany joined the C.P.R. in 1907 and was engaged upon survey work, later being placed in charge of the harbor construction at Port McNicoll, Ont. In 1911 he went to the Pacific Coast where he was employed on harbor development work and later was appointed engineer of the Research Branch of the Department of Colonization.

GERMAIN P. GRAHAM has resigned as deputy city engineer of Albany, N.Y., in order to accept appointment as district engineer of the Asphalt Association, with headquarters in Toronto, Ont., and Albany, N.Y., covering the Provinces of Quebec and Ontario and the northern part of the State of New York. Mr. Graham graduated in civil engineering with the class of 1903 at Rensselaer Polytechnic Institute, Troy, N.Y., and immediately after graduation he entered the employ of the city of Albany as superintending engineer in charge of road and street construction, and has been engaged continuously in that work ever since, with the exception of 27 months overseas as captain and adjutant of the Twentieth Regiment (Engineers). Upon his



return from the war, Capt. Graham was promoted to the post of deputy city engineer. During the past few years Capt. Graham has taken a special postgraduate course in bituminous materials at Rensselaer Polytechnic Institute. He is president of the Associated Chapters of the American Association of Engineers in New York State. As district engineer of the Asphalt Association he succeeds Capt. Bruce Aldrich, who resigned from that position in May, 1921, in order to become a partner in the Provincial Contracting Co., Ltd., Toronto. In his work in Ontario and Quebec, Capt. Graham will be assisted by J. E. Pennybacker, Prevost Hubbard and the many other experts at the association's headquarters in New York, and he will also be at liberty to call for assistance at any time upon the technical staffs and

laboratories of any of the many large producing concerns who are members of the Asphalt Association.

T. W. HARVIE, Chief Engineer of the Montreal Harbor Commission, was born in Old Monkland, Scotland, in 1877. He was for six years on the engineering staff of the Clyde Engineering Trust and afterwards became engineer for Sir Robert MacAlpine and Sons on the construction of Yorkhill Docks. In May, 1907, he was appointed assistant engineer on the staff of the Montreal Harbor Commission and was for three years resident engineer on the construction of the new Victoria Pier and Market Basin, the shore wharves and the upper section of the High Level Railway. Mr. Harvey is an Associate Member of the Institute of Civil Engineers, London, England; Associate Member of the Engineering Institute of Canada, and a member of the American Association of Port Authorities.

OBITUARIES

WM. BOND, one of the oldest contractors of Woodstock, Ont., died there recently, aged 82 years.

ANDREW MAXWELL, a prominent architect and engineer, died at Holland, Man., recently, aged 77 years. The deceased was born in Montreal and graduated from McGill University in 1855. He took up survey work with the C.P.R. in 1872, and later with the Hudson Bay Co. He settled down in Holland in 1880 and has resided there since that date.

ARTHUR FERLAND, the well-known mining pioneer, died at Haileybury, Ont., on February 9. Mr. Ferland was born in Perth, Ont., in 1865 and at one time was connected with a firm of contractors. Ultimately he went to Haileybury and was one of the original stakers of the Nipissing Mine, and later became identified with the Chambers-Ferland mine.

NEW PUBLICATIONS

INSTRUCTIONS FOR INSTALLATION, OPERATION & MAINTENANCE OF W. & T. CHLORINE CONTROL APPARATUS. Wallace & Tiernan, Inc., Newark, N.J., have recently issued a most useful book for those who are interested in the installation and operation of their apparatus. Those who have charge of their machines will find this recent publication a most valuable help, for in addition to detailed descriptions of the various parts of the machine and careful instructions regarding their various functions, the booklet contains some very helpful diagrams showing just how the apparatus should be installed and those of our readers who have not yet secured a copy of this pamphlet are advised to write to Wallace & Tiernan, Ltd., 73 Adelaide St. E., Toronto, for a copy which will be gladly sent upon application.

ENGINEERING BULLETIN NO. 1 issued by the Maryland State Department of Health and compiled by chief engineer Robert B. Morse. The bulletin contains a number of papers selected from many that have been prepared either entirely or partially by members of the engineering force of the State Department of Health bearing on various phases of work undertaken by the Department. The papers deal for the most part with such subjects as filtration and chlorination of water, quality of water supplies and filters. The studies upon which the papers are based have been carried out almost entirely in the Department, but they contain many features of general interest to engineers and it is these that have been embodied in the bulletin. Although the articles have appeared in the journals of the technical societies or in the engineering press, it was a happy idea to have them published again in one volume, and for this reason and also because of the valuable information contained therein, the bulletin will be welcomed by engineers. We hope that the Department of Health will continue to publish these very interesting bulletins.

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Water Waste Survey and Metering In Detroit City

Pitometer Surveys Show Many Underground Leaks and Eliminate Considerable Waste — Systematic Metering Adopted Reduces Water Consumption and Effects Great Saving — Consumption for Various Services

BY GEORGE H. FENKELL

General Manager, Board of Water Comm., Detroit, Mich.

THE INFORMATION that has been gathered on the consumption and waste of water in Detroit is of interest for several reasons:

1. A water works system was installed in Detroit nearly 100 years ago, and pipes laid 80 years ago are still in service.

2. Ninety-eight percent of all active service connections are now metered.

3. A pitometer survey covering the entire city is nearing completion.

4. As Detroit is served with a direct pressure system hourly records of consumption are available.

5. Detroit is the largest city in point of population in the United States, and the writer believes in the world, having nearly all of its connections metered.

6. As the quantity of water available from wells has been negligible, the people of Detroit have been at all times compelled to obtain their entire supply for domestic purposes from the distribution system of the water works.

Description and History

The City of Detroit is located on the north and west side of the Detroit River on land very uniform in contour, the highest point within its limits being 65 ft. above the surface of the river. The water system was installed by a private company in 1827 and in 1836 this was purchased by the city. When Detroit was but a hamlet, the settlers were unable to secure water from wells and were compelled to obtain their supply from the Detroit River, because of the nature of the material underlying Detroit and vicinity. This deposit has a thickness in Detroit of over 100 ft., and is composed of a compact bluish and unstratified clay charged with pebbles and boulders, of glacial origin, and generally impervious to the flow of the water.

Beginning with the first Government census, the population of the city has increased steadily as follows: 1810, 707; 1820, 1442; 1830, 2222; 1840, 9192; 1850, 21,019. From 1850 to the present, the population is shown graphically on the accompanying chart, and estimates recently made place the population at 1,020,700.

While the use of most of the pipe laid prior to 1853 has been discontinued, there still remains some that has been in service eighty years or more, as for example, a section of the 10-in. cast iron pipe in Jefferson Ave., laid in 1839. In 1861, or 60 years ago, the distribution system contained 39 miles of cast iron pipe, and it is estimated that about one-half of this is now in use. At present the distribution system contains 1480 miles of cast iron pipe in sizes from 4 in. to 48 in. in diameter, and 3 miles of 48-in. steel pipe.

In 1886 the use of a reservoir was discontinued,

and since that date the system has been operated as a direct pressure system. The first Venturi meter was set in a discharge main in 1902, and since 1913 all water pumped has been metered at the pumping station, and before 1913 allowance was made for pump slippage. The service connections are of lead and cast iron.

Beginning of Systematic Metering

Systematic metering was begun in 1889, when 194 meters were installed, and by the end of 1890 this number was increased to 856. The accompanying chart shows that approximately 10 percent of all services were metered by 1897, and this ratio of the number of meters to the number of service connections continued fairly steady until 1912.

It will be seen by referring to chart No. 1 that in 1882 the per capita consumption was 120 gals. per day and in 1887 was 209. This phenomenal increase occasioned much discussion for several years. The marked decrease from 1887 to 1891 was due to at least three causes, namely: the use of meters, which were at the time credited with all of the saving, although the number set was small; careful inspection of premises; and the installation of by-passes on the vertical compound double acting pumps. The introduction of these by-passes permitted the capacity of the two 24-mil. gal. pumps to be changed at will to 12-mil. gal. pumps. The by-passes made it possible to eliminate the waste of large quantities of water which were allowed to flow into the suction wells at times when the capacity of these pumps working at minimum speed was greater than needed to supply the city.

In Detroit, general metering was begun in 1913, and on July 1, 1920, 97.4 percent of all active service connections were covered. The greatest number of meters set in any month was 5,345 in October, 1918.

The average water pressure as determined from 39

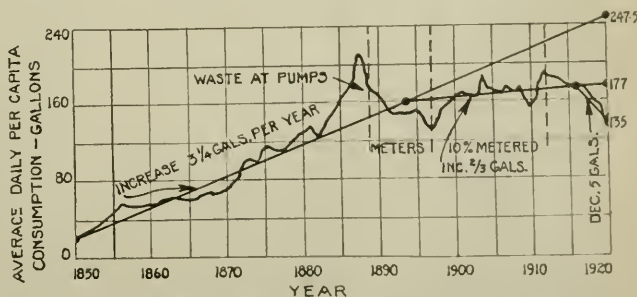


Chart 1—Average daily consumption in reference to population and effect of metering on water waste.

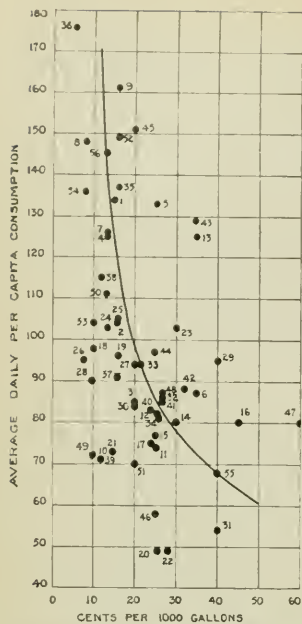


Chart No. 2—Decrease of consumption as price increases.

pressure gauges generally located in fire engine houses, in various parts of the city and read hourly, is 31.5 lbs., the maximum pressure is 45 lbs., and the minimum pressure is 22 lbs.

Consumption and Waste

The items that enter here may be divided and classified in various ways. A table has been prepared in the way that was most convenient for use in collecting the data, and the following explanations and remarks relate to this table.

In computing the quantities based on meter measurement, an allowance of 5 percent has been made for under-registration of meters. The first item covers 131,692 metered domestic accounts. This number was arrived at by subtracting the number of commercial accounts,

as estimated from a careful examination of the city directory, from the total number of metered accounts where meters were one and one-half inch or smaller.

The water furnished 2,985 domestic flat rate accounts is estimated by allowing one thousand gallons for every five cents of revenue. The meter rate in force is on a quantity basis and is one dollar for the first thousand cu. ft., fifty cents per thousand for the next three thousand cu. ft., and thirty-five cents per thousand for all additional.

On June 10, 1920, there were 164,779 service connections of all sizes in the city, and of these 145,053 were in use. On May 1, 1921, it was estimated that the area covered by the water waste survey contained about four-fifths of the total population of the city. The total number of service leaks found by this survey in this area was 447, wasting 4,359,000 gals. per day, or approximately 10,000 gals. for each service per day. All of the water wasted by the service leaks just mentioned was unmetered. By pitometer measurement 116 of these were found to be wasting 2,704,000 gals. per day, or about 23,300 gals. each. The remaining 331 were small service leaks which were located in connection with the inspection of the houses for leaks and are estimated to have averaged 5,000 gals. per day each.

The population of Detroit in 1920 as determined by the United States census was 993,739, and at present it somewhat exceeds one million. For the purpose of this paper, a population of one million has been used, and it is believed that no serious error has been introduced by the use of this figure.

All services having meters 2 in. or larger are considered to supply factories and other commercial users, 1,219 in all. This number includes some large apartment houses, but it is believed that the error introduced is small.

The number of stores and other commercial accounts which is estimated to be 7,416, was arrived at by an examination of the city directory as previously explained. The water used for building purposes is found by allowing 1,000 gals. for every five cents revenue in the same manner as with the domestic flat rate accounts.

All water supplied to villages and factories outside the

city limits is metered and the number of domestic consumers so supplied is negligible.

A careful estimate shows that 30,644,000 gals. of water were used in extinguishing fires during the year ending June 30, 1917, and it has been assumed in preparing this estimate that there has been an increase of 40 percent since that time in the use of water for this purpose.

Up to May 1, 1921, the Pitometer Company had located, uncovered and stopped leaks in mains amounting to 2,533,000 gals. per day. During the past year there were 75 breaks in mains, and it is estimated that this loss amounted to 32 mil. gals. Of these broken mains, 5 were 24 in. in diameter or larger. Great care has been used by the department in laying large mains, and the following test is mentioned to show the result of careful workmanship and good inspection. In 1909 a section of 48-in. cast iron pipe 14,907 ft. long, containing 1,360 48-in. joints, seven 42-in. joints, two 36-in. joints, and thirty-eight 12-in. joints was tested after closing two 48-in. valves, one 42-in. valve, one 36-in. valve, and fifteen 12-in. valves, by supplying the entire line through a 1-in. meter for a period of 20 hours, and the quantity so supplied amounted to 690 cu. ft. which was at the rate of 258 gals. per hour.

The estimate of the total amount of water furnished for municipal purposes is 17.44 gals. per capita per day, or 12 percent. of the total pumpage, or 13 percent. of the total quantity of water consumed within the city limits. Included in this is 0.39 gals. furnished free to charitable institutions and 0.95 gals. at one-half rate to other charitable institutions. The Department of Water Supply receives no revenue for 12 percent. of the water supplied the city. Flooding trenches is credited with 7 cu. ft. per lineal foot for 200 miles of trench. The estimates for paving, sprinkling, and flushing streets, and for flushing sewers are based on data furnished by the Department of Public Works. Four of the 42 engine houses are metered. The water used in 15 ladder houses is estimated. Five of the eleven police buildings are metered, and the supply of five parks, including Belle Isle, is metered. There are 12 unmetered park fountains, and the Pitometer Company found the average daily consumption for each of these to be 45,000 gals. There are 150 continuous flow sanitary drinking fountains on the streets of the city, each of which is estimated to use 1,100 gals. per day, and 150 horse fountains, each using, as determined by measurement, 15,000 gals. a day.

The Public Welfare Commission during the winter months makes use of eight skating ponds, and it is estimated that each has a capacity of 20,000 cu. ft., and that it is filled four times a season. All of the 14 public libraries are metered, 123 of the 161 public schools are metered and the water used in 75 private schools is estimated. Of 35 other public buildings, 8 are metered. There are 32 charitable institutions receiving free water, and 30 on a half-rate basis, all of which are metered.

The quantity used for flushing mains includes that used for filling new mains and making blow-offs of dead ends,

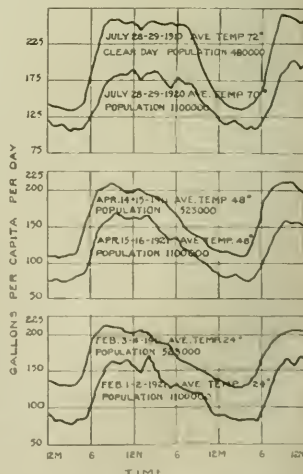


Chart No. 3—Hourly consumption of water in Detroit and suburbs—Entire system.

This information on the minimum night domestic consumption is meagre and conflicting, and any conclusions drawn from it must be in error to some extent. The amount used in these estimates, 22 gals. per capita, is probably a fair average for Detroit.

Gals. Per Capita

Manufacturing night consumption, metered, covering district including 80% of the population	19.82
Underground leakage, measured, covering same district	8.91
Underground leakage, not measured, 650 miles of mains @ 3,000 gals. per mile	2.41
Public night use, estimated	10.92
Night domestic use, estimated	22.00

Total consumption accounted for 64.09

The minimum night rate furnished 80 percent of the city as measured by pitometer, was \$6.42 gals., and the difference between this amount and the 64.09 gals. accounted for is 22.33 gals.

In an endeavor to secure data on fixture leakage, an examination of the waste survey records was made, and of all of the leaking fixtures examined, the inspector reported the flow for 4,336. The waste was metered in 90 percent of these, and the balance estimated. The waste amounted to 4,238,196 gals. or at the rate of 977 gals. per leaky fixture, with 80 percent of the population included in the district surveyed, 17,597 leaking fixtures were discovered, which at 977 gals. accounts for 17,192,269 gals. per day. This is probably 10 percent below actual leakage, for in many blocks where the night consumption was reasonable, no house to house inspection was made.

When the quantity just mentioned is increased 10 percent, the leaking fixture waste, as determined in this way, amounts to 23.64 gals. per capita, which checks the 22.33 gals. mentioned above.

No way has been found to closely estimate the amount of water lost through domestic carelessness. It is known that hose is allowed to run all summer when families are out of the city, that laundry tub fixtures are frequently kept open for long periods, and that scarcely a day passes but one member of each family allows water to waste needlessly for a few moments, and that in other ways considerable quantities of water are wasted through carelessness. In order to complete this estimate, it will be assumed that each of the 150,000 connections be allowed to waste for 5 minutes each day at the daily rate of 3,000 gals., and this is found to amount to 1.5 gals. per capita.

The estimate of daily consumption will now appear as follows:

Gals. Per Capita

1. To prevent freezing	0.75
2. Lawn sprinkling	0.90
3. Leaks in service connections	5.45
4. Leaks in fixtures	22.33
5. Carelessness	1.50

Total 30.93

The quantity subtracted from the total domestic consumption leaves 25.23 gallons for domestic use.

Metering in Detroit

While the use of meters in Detroit is said to date from the year 1888, the report of the department for 1878 contains an item of \$2,700.00 (estimated) for "Metre-measured water," and in the report of the Board for 1883 the following appears.

The Board is fully aware of the wanton and unjustifiable waste of water both now and for most of the time the Water Works has been in existence. The waste has been much more of late years, for a far better head of water has been furnished than formerly, which has enabled the wasting class to do an increased business. Other cities have the same evil, but no remedy has yet been found and may not be until the fertile brain of some man brings out a cheap and reliable meter."

The few meters and indicators installed prior to 1889

had no appreciable effect on consumption. By referring to the accompanying chart, No. 1, it will be evident that disregarding the increased pumpage between 1883 and 1890, due to waste at the pumping station, there was a fairly uniform increase in the consumption of water from 1850 to 1893 of 3 1/4 gals. per capita per year. Because of variations in temperature and precipitation from year to year, and for other reasons, the consumption line has its ups and downs, but its general direction is well represented by a sloping straight line and if continued would have approximated 247.5 gals. For a few years preceding and following 1890, careful attention was given to house to house inspection, and the effect of this work combined with that of meters and decreased use of water because of an industrial depression, produced a change in the direction of this line.

By 1897 ten percent of all services were metered, and this ratio of metered to unmetered connections continued fairly uniform until 1912. During this period from 1893 to 1913 the use of water increased fairly uniformly at the rate of two-thirds gallons per capita per year, and this line produced indicates that had the policy of metering ten percent of the connections continued, the consumption in 1920 would have amounted to about 177 gallons per capita.

About 1914 the work of metering all consumers was begun, and in 1919 the water waste survey was undertaken with the result that there has been a decided decrease in the consumption of water. The line on the chart No. 1 indicates that from 1916 to 1920 this decrease has amounted to about 5 gallons per capita per year.

Accepting the lines on the chart as reasonable, the consumption in 1920 would have been 248 gals, had no meters been set and had waste been restricted only by house to house inspection; to 177 gallons had the policy of metering ten percent of services been continued; and with all connections metered and with the aid of a water waste survey, the consumption may be expected to approximate 135 gals. per capita.

In a direct pressure system the plant must be capable of supplying water at the maximum hourly rate; and thus the effect of metering on the maximum hourly rate becomes of great importance. The quotient obtained by dividing the maximum hourly pumpage for the year by the average hourly pumpage is given as follows for several years past:

1910	1.73	1915	1.52
1911	1.75	1916	1.51
1912	1.59	1917	1.55
1913	1.75	1918	1.50
1914	1.64	1919	1.63
		1920	1.55

As normal pressures were never maintained during periods of high pumpage previous to the time meters were set in sufficient numbers to lower the pumpage appreciably, it is apparent that the maximum hourly use has been reduced to even a greater extent than the average. That is, that while from 1910 to 1914 inclusive, the maximum hourly rate with low pressures exceeded the average by 70 percent, from 1915 to 1920 inclusive, the maximum hourly rate with pressures nearer normal, exceeded the average by 55 percent. Likewise it can be shown that the increases of the maximum daily consumption over the average daily consumption has been reduced from 44 percent for the period from 1910 to 1914, to 32 percent from 1915 to 1920.

Previous to metering to any extent, a strenuous attempt was made to limit waste by house to house inspection, and this work was continued for some years to an ever lessening degree. As metering increased this inspection work decreased until in 1910 it was negligible. The number of employees required to carry on efficient semi-annual inspection work is but little less than the number needed for quarterly meter reading.

Underground Leaks Stopped by Survey

Consumers have looked on metering with favor and there has been no opposition to the movement from any class.

When the water waste survey was undertaken by the

Pitometer Company in 1919, that company assumed that this work would result in the location and stoppage of at least 20 million gallons per day. This company based its estimate on a consumption of 150 million gals. per day for a population of one million, and on the assumption that the metering of all service connections was automatically controlling domestic waste.

The survey up to May 18 has stopped underground leaks from all causes amounting to about seven million gals. per day. These leaks have been located in an area containing 80 percent of the population, covering 70 percent of the consumption, and including one-half of all the mains in the city. It seems probable that when the survey has been completed 10 million gallons of underground leaks per day will be stopped. This discrepancy between the estimated and actual underground leakage is due to the fact that meters have not eliminated metered leakage through fixtures, although such leakage has been greatly curtailed. The estimated waste existed, but was divided between house waste and underground leaks.

During the last few months a large number of the oldest small meters were removed and tested, and many of the older large meters were tested in place. From this an attempt was made to determine the error in registration, but as the accuracy of a meter that has been in service for some time varies greatly with the flow, it was thought unwise to make use of averages secured from this data. The meters removed included several different makes.

There are several factors that influence the use of water in a city and make it difficult to compare the consumption of one city with another. Chart No. 2 shows that the use of water decreases as the price increases. The figures represent 56 different towns in the United States. The water supply and other conditions in these 56 cities, each with a population exceeding 25,000, vary to such a degree that no law or rule can be found, yet the free-hand line drawn on this chart indicates that a relation exists between rates and quantity used.

Not only does pumping station data show that meters have greatly lessened the use of water for lawn sprinkling, but it is very evident to the observer, and notwithstanding this decreased use, lawns are not generally less green than formerly, for greensward and shrubbery are often injured by the application of too much water.

The amount of water used is also dependent on, (1) temperature in winter; (2) temperature and precipitation in summer; (3) condition of business, that is, whether good times or hard times prevail; (4) the class of people supplied.

Hot, dry summers increase greatly the demand for water for cooling and sprinkling purposes. During cold winters much water is sometimes used to prevent the freezing of service pipes, but when made necessary by such pipes being too near the surface of the ground, the metering of the connections will force the owners to lower these prices. The water department has been called on to lower a number of mains, and many services have been relaid because of the information that has been obtained regarding their depth since meters have been used extensively.

Business conditions affect considerably the amount of metered water used for domestic purposes as well as for factories, railways, hotels, stores and other commercial consumers, while the consumption of such unmetered consumers is much less affected. As the amount of water used depends to some extent on the kind or class of people composing the city's population, it may be expected that the per capita consumption for the past few years would from this cause be increased in Detroit, for the percentage of young men liberally reimbursed for their labor has been exceptionally high.

The rule in Detroit has been for domestic consumers to prepare their plumbing for meter, and for the Board to set and maintain the meters without charge or rental. While the department regulations require meters to be set horizontally, experiments were made to determine the relative wear of meters when set vertically and horizontally by run-

ning meters of seven different makes in test to destruction. The number tested was small, and the results were not conclusive, as the difference was not great.

In May, 1919, the Pitometer Company was employed to conduct a water waste survey of the distribution system of the city. The city was divided into seven sections, and at this date, May, 1921, five of these sections have been completed and about 50% of the sixth section has been surveyed.

Water Waste Survey

The general purpose of this survey was to account for the water supplied to each section; or to reduce the amount by locating and stopping underground leaks in the mains and services. The survey also furnished a check on all industrial consumers for the purpose of discovering unauthorized use of unmetered water, and included a field test of all meters larger than three inches in diameter. Each section was divided into as many districts for individual study as was made convenient by the location and size of the larger mains of the distribution system, and the consumption for a period of 24 hours was obtained by pitometer measurement.

To date 120 districts have been measured and permanent gauging points established in each district for the future control of waste. The area surveyed includes about 80 percent of the population, and 50 percent of the miles of main in the entire city distribution system, consuming 106 million gallons a day, or 132 gals. per day per capita. The total minimum night rate in the districts measured amounts to 69 million gals., or a per capita of 85 gals. per day.

Meters larger than 3 in. in diameter, to the number of 356, have been tested under field conditions, and in many cases an under-registration has been found. These have been repaired, and in consequence the revenue of the department has been increased. So far there have been no cases discovered of the unauthorized use of water, and this satisfactory condition found in the older, more densely populated portions of the city, may be accounted for in part by the metering of many fire lines and the quite careful inspection of the remaining fire lines.

Leaks in mains and hydrants have been found as follows:

	Gals. per day
4 Broken Main	562,000
12 Joint Leaks	861,000
3 Open Blow-offs	800,000
2 Blown Plugs	190,000
3 Valves with bad stuffing box leaks	85,000
2 Defective Fire Hydrants	35,000
	2,533,000
	Gals. per day
Leaks discovered by the survey include the above and 116 service leaks caused by broken pipes, abandoned services, and blown corporation cocks	2,704,000
331 service leaks estimated at 5,000 gals. ea.	1,655,000
Waste by broken mains, etc., ...	2,533,000
	6,892,000
A total of	6,892,000

Caution

In the estimates contained herein, quantities are frequently given to one or two decimal places. It is not the intention to imply from this that the number of gals. of water consumed for various purposes has been determined with great accuracy, for many of the quantities have been found by estimate rather than by measurement. In fact, there is scarcely an item that may not be in error. The reader is also warned against applying the results herein obtained to other cities without giving careful attention to the varying conditions which will be found to exist in Detroit and in the city under consideration.—Paper read at American Water Works Association Convention, Cleveland, June 6-10, 1921.

REPORT OF COMMITTEE ON TOPOGRAPHICAL AND EXPLORATION SURVEYS

Report Presented at the Meeting of the Association of Land Surveyors in Toronto Last Week. Review of Survey Work Undertaken by Committee.

By J. W. Pierce, D.L.S., O.L.S.,
Chairman of the Committee

A NUMBER of surveys that might properly come within the scope of the Committee on Topographical and Exploration Surveys were carried on during the last year at widely scattered locations in the Dominion. A brief reference to the more important and interesting of these would probably be the best means of drawing attention to recent progress in these branches of surveying.

Manitoba-Ontario Boundary

To delineate part of the boundary between the new area added to the provinces of Ontario and Manitoba, about 70 miles of line were run north from Winnipeg river, township 15, during the 1921 season, under the joint auspices of the Dominion and Ontario Governments. The wise policy of defining this line in a permanent and accurate manner, together with the securing of the maximum information on the adjacent country, brought up some interesting points of organization and operation for which there was very little previous data that could be used as a guide.

The supplies were cached in the vicinity of the line during the winter and survey operations were carried on from the early part of June to the middle of October.

The party consisted of twenty-five men, comprising the surveyor in charge, J. W. Pierce, 1st and 2nd assistants, one leveller, one instrument man, one topographer, two rodmen, one front chainman, one cook, one cookee, one head packer, one monument builder, one picketman, seven axemen, four packers and canoeemen. The transportation throughout was man-packing, except where canoes could be used over water routes.

A very accurate method of chaining was used by means of two supporting tripods and chain. On one of these tripods there was a transit for the measurement of slope and alignment while the uniform tension was obtained, using a spring balance and straining bar supplemented by an arrangement of pulleys which when tightened to the proper tension were locked thus making it possible for two men to carry on the operations. The temperature readings were obtained by the use of thermometers. The chain used was compared at intervals with a standard which previously had been compared in the surveys laboratory at Ottawa and corrections determined for its length and sag. A check chainage was made throughout with a three-hundred foot chain with pins, plum bobs, clinometers and thermometers as a check against gross errors.

Levels were run over the line to determine the elevation of the monuments placed and the adjacent summits, depressions, and water levels. In addition to the main line of levels, an independent line of levels was run as a check and an accurate closing obtained over each division before proceeding to the next. Eleven concrete monuments were established on which were placed plates indicating the respective provinces on either side and at points in between these were placed subsidiary brass cap monuments of the type used on Dominion land surveys. In nearly all cases the latter were the short type of post cemented in the rock. These secondary monuments were given prominence by an adjacent rock pyramid, 5 ft. square at the base and 5 ft. high.

The final production of the line was made by a base line transit with sights averaging one and one-half miles. Observations were taken for azimuth usually at two or three-mile intervals and the direction of the line corrected thereby. The line was produced through country almost continuously wooded, and some of the timber being of commercial value. The lakes intersecting the line or close

thereto, were traversed by stadia. A geological party under Dr. Burwash, was attached to collect information for the Ontario Department of Mines on the country adjacent to the line.

Alberta-British Columbia Boundary

The survey of this boundary which has been in progress for some seasons was continued in 1921 under the jurisdiction of the two adjacent provinces and the Dominion. Operations were confined to the mountain sections.

Revision of Section Sheets of Western Canada

During the past few years the Topographical Surveys Branch have, in its program of revising sectional sheets in the West, been collecting and adding a great deal of topographical information to meet the requirements of the industrial, agricultural and tourist interest.

These maps, in addition to showing the regular projection of township outlines, sections and quarter sections, as on the old type of map, have many other items of interest. All roads have been classified, after expert investigation, upon the basis of relative importance as traffic arteries, rather than on a physical condition which is apt to vary widely under seasonal and weather conditions. Trunk roads, for example, as main routes between important but more or less widely separated centres, have been distinguished from secondary roads, often equally good as to physical condition, but limited in importance to the linking up of settlement and as feeders. All buildings, that is, all farm dwellings and other buildings such as churches, schools and blacksmith shops, are shown in accurate location and by special symbols. The whole area is contoured at a fifty foot interval and large wooded areas, telephone lines, mines, etc., are shown. These maps have met with a strong appreciation as reliable information of this kind has been long wanted. The scale of publication is three miles to an inch.

In the field, operations were carried on with a party of six or seven men usually equipped with two touring cars and a truck. Two sub-field parties operated out of each camp with a touring car each and collected information, using the township plans on a scale of forty chains to the inch as a base for sketching and recording the notes.

Supplemented by existing level data, the information on the contours has been largely obtained by aneroid barometers and this work has been developed to a comparatively high degree of accuracy. Control is usually laid down by means of spirit level and stadia level at six mile intervals and the barometers closed on this as far as possible at intervals of time not exceeding one-half to one full hour. Three barometers in each car are read in each case to eliminate erratic deflection on the part of any one instrument. Camp barometers are also read for control during the hours of field work. The results obtained show that the barometric levels have in the large majority of cases closed within ten feet and quite frequently less.

One sectional sheet of about 120 townships is the usual area covered by a party in a season. Relief maps of these areas have been constructed by the same branch in its relief map department and the full topographical information reproduced in colors on the surface with a very fine effect. These models are used by Provincial and Dominion organizations in the study of soil and geological formations, and in dealing with problems of settlement and development such as drainage, irrigation and roads. It is found that a much more realistic and intelligent impression of the ground can be given to laymen, officials and commissioners, by this means than by the contoured map alone.

Mackenzie River Control Traverse

For the purpose of establishing control surveys for the "tying in" of mining claims and oil leases in the Mackenzie valley and to serve as a base map for geological investigations, a stadia traverse of Slave river, part of Great Slave Lake, and the Mackenzie river was carried on extending from the 30th base line to about 100 miles below Norman,

and also about half way up Great Bear river. In this work a separate stadia traverse was made on each bank and ties made from one bank to the other as frequently as possible. Permanent monuments were established at intervals of from two to three miles. Check on the traverse was obtained by observations for latitude and longitude at Resolution, Providence, Simpson and Norman, under the direction of Dr. Klotz of the Dominion Observatory. The total mileage of shore line surveyed amounted to 4,016 miles.

The parties were organized at Edmonton by the Topographical Surveys Branch and went from that city by railroad to the town of Peace River. From this point scows were used, one per party, thus enabling each party to carry their own supplies direct to their work. The only breaks in navigation by this route are at Vermilion Chutes on the Peace river and at Smith portage on the Slave river. At the latter place a 16-mile portage must be made. By getting away from Peace River as early as possible after the break-up of the spring, the parties were able to get forward their supplies across the portage at Vermilion Chutes and arrive at the Smith portage in advance of the first steamers. The early break-up of ice in Great Slave lake last spring permitted the scows to leave Fort Smith several weeks sooner than expected and enabled the various parties to commence their work on the Mackenzie river about two weeks earlier than if they had relied for transport on the regular steamers supplying the northern trading posts. In addition to the advantage of having an independent transport and the time and expense saved thereby, the scows were found very convenient on the actual work, as the cook tent was arranged on the scow and moving camp only required dropping down river with the scow to the point where the working parties would finish in the evening.

Exploration of Northern Saskatchewan

In 1920 the Saskatchewan Provincial Government sent a party to the northern territory of that province for exploration purposes and in the following year, a second party investigated the area with the purpose of making a close study of the features emphasized by the previous year's party in the Bear Hills district. In addition, the south side of Lac la Ronge was examined and the valley of the Muddy river.

The Bear Hills are comparatively unknown, being difficult of access to the traveller. They cover an area of from 60 to 80 miles across the broadest part by from 100 to 120 miles in extreme length.

Shales were observed which may prove to be oil-bearing in character and outcrops of lignite were found which seemed to be of good quality. One mineral somewhat widely found was bog iron ore and this was so plentiful that it would seem to indicate at least that the source from which the ore was derived does not lie far distant and may be developed by more detailed examination.

The timber is somewhat mixed and that of commercial value is widely scattered and only found in small groves. It will be most useful as a local timber supply for incoming settlers.

Topographical Survey of London, Ont.

The Geodetic Survey Branch, Ottawa, during the season 1921 made a topographic survey of part of London, Ont. It included the six more or less distinct operations; precise level net, secondary level net, triangulation net, traverse net, the measuring in of the natural and artificial features to be shown on the map and the locating of the contours showing the configuration of the ground surfaces. Geodetic methods were followed throughout. Four of the thirteen triangulation stations from which observations were made form a quadrilateral of the primary triangulation of Canada. The precise level net consists of forty-one miles of line. Ninety-five permanent bench marks were built and their elevation established.

Stereophotogrammetric Surveying

A new method of photographic surveying, stereophotogrammetric surveying as it is called, has recently been tried out for the first time in America on an extended scale, in

the vicinity of Thirty-one-mile lake district of the Province of Quebec. The only instrumental outfit in Canada at present for this work is owned by the University of Toronto. It was loaned to the Geodetic Survey during the fall of 1920 and the method tested out in a practical way over an area of about one hundred square miles.

In the old method of photo-topography, topographic control points were plotted from photographs taken at widely separated stations from one to ten miles apart. The relief had to be sufficiently varied so that the same points could be recognized in the photograph taken of them from two or more different stations. On the stereophotogrammetric method this is not necessary. Two photographs are taken at the same time by a phototheodolite instrument, one from each end of a short base in such a manner that both are in the same vertical plane. The negatives themselves after development are placed in an instrument called a stereocomparator and the distance and elevation co-ordinates are measured with extreme accuracy. These co-ordinates are then scaled off on a specially prepared plotting board and the position and elevation determined.

When the positions of enough points to control the topography of a certain section have been determined and marked upon the tracing paper by which the plotting board is covered, the tracing paper is removed and the points transferred to the map. Then from an examination of the country from the photographic enlargements and a study of the co-relationship of the points, the contours are shown.

In the annual report of the Superintendent of the Geodetic Survey of Canada to be issued, for the year ending March 31, 1922, it is intended to give a detailed account of the field and office methods and the theory of the field and office instruments in connection with this work.

WILL PREPARE A CITY PLAN FOR MONTREAL

WORK on the preparation of a city plan for Montreal will be started this year according to Chairman Brodeur of the Executive Committee. The extent of a general plan of Montreal may be judged by the fact that it is estimated it would cost from \$600,000 to \$800,000 and would take ten years to complete.

On the other hand a general plan of the Island of Montreal is declared to be a fifteen-year job for a staff of engineers, working all the time taking notes in summer and making the plan in winter at a cost exceeding \$1,000,000.

Such a plan would indicate, for example, the levels and dimensions of streets, and it would also show the correct dimensions of all buildings and blocks of buildings, the measurements, requiring accuracy, would be taken to the one-tenth of an inch. The object of this is that when later the public works department would require the length of a building for one purpose or another they could get the information from the said plan without having to go back to the place and measure it.

Then the street levels and those of sidewalks must be indicated in such a plan as, for example, if a sewer is to be built the department would require to know what are the levels and grades.

This general plan would also indicate the location, the size and dimensions of all sewers, water and gas pipes, and the underground conduits. The advantage of having this information in the office would also be realized when it is proposed to construct a sewer, as the plan would indicate the existing sewers, their size, the street grade and the like.

A. H. Milne, British Trade Commissioner for Canada and Newfoundland, announces that a British firm in competition with American manufacturers has secured a contract with the Provincial Government of Manitoba for the installation of a six-thousand-line automatic telephone exchange for the Fort Rouge district of Winnipeg. The contract amounts to about \$483,000.

OTTERTON AUTO-EDUCTOR

Canadian Company Formed to Manufacture Combination Machine and Otter Municipal Equipment

MUNICIPAL engineers throughout Canada will be interested in the announcement of the formation of the Canadian Municipal Equipment Corporation, Ltd., who intend to manufacture in Canada a line of improved municipal equipment for cleaning streets and catch-basins.

Offices have been established in the Bank of Hamilton Building, Toronto, with Wm. H. Cooke, Toronto, as president and general manager; Geo. W. Otterson, formerly of the Otterson Auto-Eductor Co., of Springfield, Ohio, as consulting engineer; and Charles C. Smith, of Chicago, as automotive expert.

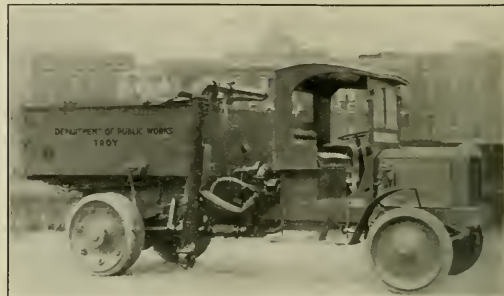
While the company is making arrangements to act as Canadian manufacturers for two well-known lines of American municipal equipment, their main product will be the Otterson auto-eductor, which is a combination street flusher, sprinkler, sprayer, catch-basin cleaner and emergency fire apparatus.

This combination machine will no doubt appeal to many small municipalities which cannot afford to purchase individual machines for each of these operations, but where the town engineer would find a combination machine very useful in keeping his streets and catch basins clean, and as an emergency fire apparatus.

This combination machine has been built in the United States for the past ten years, and is used in all of the large cities throughout that country, and was used in the Government military camps during the war. Mr. Otterson is in possession of some excellent testimonials with regard to the savings effected by its use.

The following are among the work that can be done with the auto-eductor, states the company: Sprinkling and flushing streets and roadways; draining swamps and flooded lands; cleaning latrines, cess-pools and dry-wells; cleaning catch-basins and sand-catchers in city sewers; flushing and blowing out sewers; caisson pumping; salvaging flooded materials; emergency fire protection; hauling water for

The method formerly used in most cities for cleaning catch-basins was to equip men with long-handled shovels, with which they spooned out the detritus and piled it in the gutters until collected by a wagon. This unsightly, unsanitary and offensive system is entirely eliminated by the auto-eductor. Within a few minutes after this machine has run alongside the catch-basin, the detritus has been pumped



AUTO-EDUCTOR WITH PIPING TELESCOPED—READY TO TRAVEL

from the basin to the closed bed of the auto-eductor, and the basin is thoroughly flushed and cleaned.

Although all new auto-eductors will be mounted on the company's standard chassis, if a municipality already owns a chassis, it can be fitted with the necessary equipment. The high customs duty has previously prevented the sale of many auto-eductors in Canada, says Mr. Cooke, but now that the Canadian patents have been purchased by a Canadian firm and the machine will be manufactured in Toronto, he expects to be able to place the auto-eductor within the reach of even the smallest municipalities.

The auto-eductor consists of the following parts, mounted on a five-ton chassis: (1) The body, (2) a hydraulic hoist for raising and lowering the body, (3) eductor (with its connections), (4) centrifugal pump.

The body is designed to separate the solid matter removed from the catch-basin, cess-pool or sump, from the water which has carried it to the body. The separation is accomplished by three sheet-steel baffle plates, one of which is a screen. The baffle plates and screen are located at regular intervals from the front to the rear of the body. Each baffle has a properly proportioned opening, these openings being on alternative sides of the body. The screen, which is located between the front of the body and the first baffle plate, is of the same material as the baffle plates, and the greater part of its area is perforated with closely spaced $\frac{3}{4}$ -in. holes. The baffle plates and screen are hinged on substantial steel rods which extend across the body. These plates swing freely and do not in any way obstruct the passage of the contents of the body when dumping. The baffle plates and screen are removable.

At the front and on the bottom of the body is an outlet which is connected to the suction of the pump. This outlet is controlled by a quick opening and closing valve located just under the body in front and at the right-hand side, forming a connection between the body and the upper half of the suction coupling. A similar valve is connected just aft of the suction-connection coupling cross-connection. This valve is known as the "over-flow valve," and as the solids replace the water in the body, this allows the excess water to flow into the catch basin, cess-pool or sump, through a pipe provided for this purpose.

The rear of the body is closed by a tail-gate hinged at the top. It is made water-tight by means of a rubber gasket. The gate is held firmly against the gasket by means of swivel clamp. A standard dump-body tail-gate clamp which is operated from the front end of the body, holds the gate closed after the swivel clamps have been loosened and swung clear of the gate. This prevents the operator



OTTERTON AUTO-EDUCTOR CLEANING CATCH-BASIN

road construction and other purposes; hauling sand, gravel or other supplies; draining flooded pits or trenches; or any other miscellaneous pumping or hydraulic work required by a municipal engineer or contractor.

Considerable economy is shown by the auto-eductor in cleaning catch-basins, as from sixty to eighty basins can be cleaned in one day. These auto-eductors are now working in various cities, cleaning basins from six to sixty feet in depth.

from being deluged with mud and water when he loosens the swivel clamps preparatory to dumping. The body is provided with splash plates on and across the top at front, sides and rear, which prevent the water from spilling while the machine is in motion.

The body is raised for dumping by a vertical hydraulic hoist. The operation of this hoist is easily controlled by the driver from his seat.

The eductor, or the ejector device, consists of a small casting in which is created a suction by the pump pressure, which draws the contents of the catch-basin, cess-pool or sump through an opening in the side. This refuse is then elevated and discharged into the body. The pressure is transmitted from the pump to the eductor through a length of hose, a short piece of iron pipe, and a return bend, to which the eductor is attached. The hose is used to give flexibility when working at various depths. The refuse is discharged from the eductor through a 3-in. tube which telescopes inside of a 4-in. tube. This allows the eductor to work at any depth from the street level to the bottom of the catch-basin. A small winch is provided on the side of the body for raising and lowering the eductor and its piping.

The entire eductor assembly is hung from a sliding arm, which permits of its operation in catch-basins at various distances from the curb. The eductor and piping, when telescoped, will clear any and all obstructions while proceeding along the street.

For the purpose of breaking up the material in the catch-basin, an agitator is attached to the pump. This consists of a length of small hose to which is connected a length of $\frac{3}{4}$ -in. pipe. The flow of water is controlled by a quick opening and closing valve located at the pump.

The pump which supplies the pressure for operating the eductor is of the centrifugal type. It has been specially designed to overcome all difficulties in this class of service that have been discovered in the experience of the Otterson Auto-Eductor Co. with hydraulic ejectors. The pump is driven by the truck motor through a specially designed transmission and is controlled by the driver from his seat. A pressure is connected to the pump in view of the driver, which enables him to control the motor speed to maintain the proper pressure at all times.

In addition to the standard Otterson auto-eductor described above, the company intends to build a special heavy-duty type of eductor for use where the lift is greater than 15 ft. This heavy-duty type is similar in body equipment to the standard type. The pump is double stage and of the same design as the single stage used on the standard auto-eductor. This pump gives the increased pressure required in working to greater depths. The eductor and connections are designed to meet the demands of this duty.

O. L. S. ANNUAL MEETING

More Than One Hundred Surveyors Attend Interesting Three-Day Convention in Toronto

COMMENCING Tuesday, February 21, and continuing for three days, the thirtieth annual meeting of the Association of Ontario Land Surveyors was held in the lecture room of the Engineers' Club, Toronto. The attendance averaged over one hundred members.

The general session opened at 2 p.m., Tuesday, with the reading of the minutes of the previous meeting, after which Geo. A. McCubbin, of Chatham, delivered the annual presidential address. He reviewed the affairs of the association for the past year in a general manner, and emphasized the need for precision in engineering work under all circumstances.

The report of the Committee on Land Surveying, which consisted chiefly of answers to questions as to methods in regard to special problems, was presented by E. T. Wilkie, H. T. Routly, Toronto, read a paper on "The Development of Townsites in Northern Ontario." H. L. Seymour, chairman of the Committee on Town Planning, presented the report of that committee.

The Tuesday evening session proved to be decidedly interesting. H. K. Wicksteed, of Toronto, described the system of transportation for both railroads and highways of Venezuela. He showed many excellent lantern slides.

Following Mr. Wicksteed's address, E. V. Seibert, of Ottawa, delivered an illustrated lecture on "Mackenzie River Work," which followed the same general lines as Mr. Wicksteed's lecture, thus providing an interesting comparison between railroad and highway transportation in the South and the North.

Wednesday morning's meeting was opened with the reading of the report of the Council of Management and Board of Examiners by T. B. Speight. The report of the Committee on Engineering, Roads and Pavements was presented by T. M. Empey. J. W. Pierce, chairman of the committee on Topographical and Exploration Surveys, read the report of that committee, outlining the work accomplished during the year throughout the Dominion. James Dickson, completed the session with an interesting paper on plans and descriptions for registration of subdivisions.

J. J. Newman, chairman of the Committee on Drainage, opened the session on Wednesday afternoon by presenting the report of that committee. He dealt chiefly with the methods of working under the Municipal Drainage Act in Western Ontario. This report was followed by papers on "Assessment for Tile Drains," by F. J. Ure, and "The Essex Border Utilities Intercepting Sewer," by M. E. Brian. Willis Chipman, chairman of the Committee on Biography, provided an interesting half-hour with the history and biographical sketches of pioneer surveyors of Ontario.

Among the guests at the annual dinner held in the club's dining room on Wednesday evening were the Hon. Beniah Bowman, Minister of Lands and Forests of Ontario; G. F. Henderson, K.C., drainage referee; F. V. Seibert, a past president of the Dominion Land Surveyors' Association; A. V. Hall, president of the Town Planning Association, Toronto; and Major A. W. Gray, M.P.P., who introduced the bill in the Ontario Legislature respecting the regulation and licensing of professional engineers.

The election of officers for 1922 took place on Thursday morning, resulting in the selection of the following:

President, Geo. Hogarth; vice-president, H. T. Routly; Secretary-Treasurer, L. V. Rorke (re-elected). Members nominated for the Council of Management, to be voted on by letter ballot, are W. G. McGeorge, Chatham; E. T. Wilkie, Toronto; J. M. Watson, Orillia; H. M. Anderson, North Bay; John M. Empey, St. Mary's; F. N. Rutherford, St. Catharines; and N. B. MacRostie, Ottawa.

The usual "Veterans' Luncheon" was held at noon, Thursday. This function, which was exclusively for surveyors who received their certificates prior to 1891 and all past-presidents of the association, concluded what was unanimously conceded to have been the most enthusiastic gathering of surveyors that has been held in Ontario for many years.

During the year ending March 31, 1921, the shipping constructed in Canada amounted to 95,838 tons. During the year ending March 31, 1920, 164,074 tons of shipping was built. During 1921, 34,623 tons of shipping with a value of \$8,456,573 was sold to other countries. In 1920 the tonnage sold to other countries was 53,407. The value was \$17,819,477. In 1868, the first year for which statistics are given, 87,230 tons of shipping was constructed in Canada. This industry reached its highest peak in 1875, when 188,098 tons reached the ocean. From 1875 tonnage constructed each year gradually declined until in 1896 only 10,753 tons passed from Canadian yards. After 1896 the amount increased until another peak was reached in 1920. In 1918, 53,912 tons of shipping was constructed, and the figures given show that this more than doubled in 1919 and more than tripled in 1920. Of the total of 220 vessels built in the fiscal year ending March 31, 1921, 139 were steamers and 81 sailing vessels. The steamer tonnage was 80,174 and the sailing vessel tonnage 15,664.

THE DEVELOPMENT OF TOWNSITES IN NEW ONTARIO

Haphazard Growth of Towns in New Ontario — Ordered Development Essential — Suggestion that Ontario Land Surveyors Should Advise on Town Planning

By H. T. Routley,
Contractor, Toronto

THE PAST history forming the basis for this paper is that of the district opened up by the T. & N. O. Ry., particularly the portion from Temagami to Cochrane and including the mining areas of Cobalt, Montreal River, Gowanda, Larder Lake, Swastika, Porcupine, etc., with the various towns, villages and camps located therein. Though not as familiar with the balance of the province lying westward to the boundary of Manitoba, I am sure that the conditions and problems in the settled portions of this area have been very similar. And the problems of the past with the lessons learned are applicable to all that great area, the very heart and centre of the future Canada, and now but indifferently understood and appreciated under the title of North or New Ontario. There are but few who have any real conception of the vastness of this area; of the unbounded wealth of its mines, forests, streams and agricultural areas. This great area situated as it is in the very heart of our Dominion, is destined, at no very distant future, to occupy a position of commanding importance in the political and commercial life of our country. I feel, therefore, that no apology is necessary in presenting to you one of the problems, not only of its past, but one of the greatest of the problems of its future, and one on which this Association is peculiarly qualified to consider and advise.

Progress of Development in New Ontario

During the years of 1910, 1911 and 1912 public men in the North and to some extent also in older Ontario, were becoming much concerned and were giving a great deal of thought and study to the question of the development of new townsites. These had been springing up all over the district, due principally to the discovery of new mining fields, and it was felt that some efficient system of control and guidance should be inaugurated, especially during the early period before incorporation. The local Boards of Trade were very much alive to the mistakes of the past and the necessity and possibility of avoiding many of them in the future. At most of the meetings the townsites problem was raised and discussed in some form or other. It was felt that the repeated devastations by fire and typhoid fever especially, were amenable to control or entirely preventable. Many phases of the question were discussed, not always with unanimity of opinion, as to causes or cures. It was sometimes difficult to keep the discussion within bounds, as political bias frequently influenced the arguments pro and con. There were salient points however on which agreement was practically unanimous and some of these were crystallized in the form of a resolution by the Halleybury Board of Trade in 1911. After much discussion this resolution was adopted by the local Board. It was then submitted to the Associated Boards of Trade of Temiskaming where it received hearty approval, and was then included in the agenda of the Ontario Associated Boards of Trade meeting in Toronto in Feb. 1912. At this meeting there were many other problems from New Ontario, all of which were of direct and immediate interest to the particular town or district initiating them, and the Townsites Resolution, not being strongly championed, received only partial endorsement at the hands of the Ontario Associated Boards of Trade. It was not rejected, but after some discussion was referred with others to the Executive Committee for further examination, consideration and action. Certain new or altered regulations respecting for example, the clearing of timber around townsites and the appointment of district medical officers would indicate that the agitation back of the resolution has since borne some fruit.

Since that time however there have been very few townsites started and the question has lain in abeyance.

The time is again at hand however when we may expect and should prepare for the development of numerous mining camps and unorganized hamlets, many of which will later develop into fair sized villages or towns, and some no doubt within a generation or two will have developed into cities. Now is the time to lay the foundations right and to start all these potential towns and cities on proper lines so as to eliminate the early dangers and also avoid many of the problems which beset our present towns, both in New and Older Ontario, because of a lack of foresight and intelligent control at their inception. It should be feasible to so guide and protect these embryo towns that they may escape the disastrous fires and epidemics, the gross errors of location and planning, the financial excesses and the many other preventable errors which have waylaid the infant cities of the past. It was this desire and feeling of responsibility to the future which moved these men of the Boards of Trade and compelled them to ponder these problems and to endeavor to find remedies. For the most part, specific details were attacked individually and a solution sought. After much time, discussion and thought, however, it had gradually become to be recognized that the various problems were all part of one main problem — The Development of New Townsites — and there had developed a public feeling that this problem should be taken hold of in a real way by competent men and given the attention and study it deserved. However, about this time, 1913, there came a period of depression followed by the war, causing a practical suspension in the opening up or development of new areas, and diverting men's minds from many of the problems which had previously occupied their attention. It was just prior to this stage of depression that the resolution, previously referred to, was considered and as it represents pretty fully and fairly the stage at which public opinion had arrived at that time, I beg leave to quote it in full.

The Townsites Resolution of 1912

"Whereas many portions of New Ontario have been proven to be rich in mineral deposits;

"And whereas an army of prospectors is continually in the field prospecting for new areas;

"And whereas it has occurred in the past and is likely to occur very many times in the future, the rush settlements which later may develop into towns and cities spring up in the vicinity of newly discovered rich mining areas;

"And whereas in the past due to lack of municipal organization, provincial or other control, these new settlements have frequently been located on unsuitable ground and built without regard to the proper allowance for lanes, streets, etc.;

"And whereas until such time as the town grows in permanent population and becomes incorporated, there has in the past been exercised no proper and sufficient control of the sanitary conditions; of the clearing and building arrangements with a view to the prevention of fires; of the arrangements for the disposal of garbage and other waste material; of the arrangements for the protection of wells, springs or other sources of water supply; and of many other functions pertaining to organized municipalities;

"And whereas the lack of such supervision and control in the earlier stages in the formation of many of the New Ontario towns has been the direct cause of serious loss by fire and serious outbreaks of typhoid fever,

"And whereas such loss by fire and epidemic is a serious and unnecessary setback to the new towns and is a loss not only to the individual camps in which they occur, but directly and indirectly to the whole Province of Ontario;

"Be it therefore resolved that the Ontario Associated Boards of Trade do hereby urge upon the Government the serious needs of instituting some plan of control of the clearing and building operations, of the street planning, of the garbage disposal, of the water supply and such other municipal functions as are necessary until such time as the municipalities become incorporated;

"That the deforestation of townsites be enforced before the sale of any part of such townsite be permitted."

As indicated by the wording of the resolution, those most familiar with the problem felt that the critical and dangerous period was in the early stages before incorporation. During that period about the only influence for good in the layout of the town was the consciousness of responsibility to the future population on the part of the surveyor employed. But since he had no real authority to control the location or layout, he was limited to the friendly tender of advice and suggestions to his clients. Indeed in many cases even this influence was missing, as several of the towns were first staked out by squatters without any surveyed subdivision or plan.

How Townsites Are Formed in New Ontario

Let me sketch the typical history of the formation of a New Ontario townsite. On the location of a rich mineral find, a rush of prospectors would stake out the surrounding country. If the discovery gave early evidence of developing into an important mine, a townsite was an immediate requirement. Stores, stopping places, amusement halls, offices of various kinds and residences would spring up as if by magic, and in a very few weeks a fair sized town was the result. The buildings were of log, frame or canvas with various combinations of these three materials, and were usually overcrowded and entirely lacking in fire protection. As soon as an embryo town was well started, real estate operators secured and subdivided nearby rival sites, with the result that there were usually three or four separate settlements closely related, but all in keen rivalry. Owing to this dissipation of the population and the uncertainty as to which section would eventually win out and be the real town, the whole population was compelled to do without waterworks, sewage and garbage disposal, fire prevention and other primary requisites of civic life, many of which would have been readily obtainable had the population been centered at one point and able to combine their resources to the best advantage. And the survival of the fittest is not always the outcome. The best natural location may lose out because an inferior one is supported by a more aggressive and influential group of men. The result may be that a community is permanently fixed on a site which is topographically, geographically and economically much inferior to a nearby site, which might just as well have been chosen, and the community is for all time unnecessarily handicapped by its location and the misguided ardor of its first supporters. And throughout its entire history, the inhabitants may have to suffer grievous burdens simply owing to the lack of proper control and guidance during the early history of the settlement. Repeated visitation by fire has been the lot, almost without exception, and typhoid has taken bitter toll in the majority of the present towns. Such has been the history of the past. Some improvements have been inaugurated, especially with regard to typhoid, but much remains still to be done before new towns will be off to an ideal start.

T. & N. O. Ry. Commission Usually Controls Townsites

Do not infer that there is no controlling agency or organization of any kind. This would be hardly correct. In the towns located on the T. & N. O. Ry., the Railway Commission usually controls the townsite by having acquired the farm lots from the Crown before any settlement has started. A portion of the land acquired is subdivided and lots advertised for sale. These, however, are often grabbed up by speculators to the loss and detriment of the real settler and the town as a whole. There is also a measure of control of other townsites, in that a subdivision plan must be submitted to the Department of Lands and Forests for approval, and to give the Government an opportunity to choose from the proposed plan one-quarter of all the lots, as per the "Act respecting Townsites" 10 Edw. VII, Chapter 9, passed in 1910. Much objection has always been felt in the North not so much to the spirit of the Act itself, but to the method of its application. The lots so chosen and also the lots retained or owned by the T. & N. O. Railway Commission, in their townsites, are removed from tax-

ation, and constitute a continuing source of annoyance and complaint, being an irritating burden on the balance of the town, which must tax itself so much heavier to make up for the lack of taxation on the lands so held waiting for the increment earned by the patience and industry of the people who make the town. It has been felt that a better plan of dealing with the Government's lots could be instituted and the question of setting aside the revenues obtained, to be used for the benefit of the town treasury, has often been suggested. These are questions worthy of study, and on which a definite policy should be laid down after thorough investigation and mature consideration.

It has been held in the past that the Railway Commission was the best body to choose, lay out and administer the new townsites along this line. There is no doubt that, in their power to limit the available building lots and so force a greater concentration of population, their control was an improvement on the haphazard and widespread subdivisions of many of the other townsites. I hold, however, and I believe the great majority of people in New Ontario will agree, that the Railway Commission is not now the proper body to control the townsites even along its own lines. It is essentially a railway construction and operation organization, and there are always questions arising between any railway and the towns through which it runs, that involve differences of opinion and policy, and where the interests of the two are sometimes much opposed. It is only reasonable to suppose that a railway commission will foresee as far as possible its railway requirements of the present and of the future, and will take care to secure for its railway, what it requires or thinks it may ever hereafter require, and the interests of the future town or city will of necessity take secondary place. I am not criticizing the personnel, past or present, of the T. & N. O. Railway Commission, for I believe that they have been very conscientious in their dealings with the various towns through which the line runs. But they are a railway commission, and it is undeniable that their first duty is to the railway. Nor is it possible for the regular staff, of an already well burdened department of the Government, to give the question the close attention, the detailed study, the personal visitation and supervision which is necessary to arrive at the best conclusions. A well thought out general policy is necessary but after that there will be frequent propositions requiring prompt and careful study and inspection so as to arrive quickly at a decision backed by thorough investigation and careful, intelligent analysis. Speedy action is most essential as will be recognized by those who were present at the birth of Gowanda, Elk Lake, Timmins and many other New Ontario towns, and this quick action can seldom be taken by a government department, especially where it is not directly organized for, and charged with the duty of such supervision.

Great Field for Town Planner

In the early days, perhaps no other methods were possible or justifiable, but the requirements have long since grown to such magnitude, and the possibilities and responsibilities of the future are so great, that no further time should be lost in planning and putting into effect a proper organization for the control and guidance of the scores of new towns which the next generation will undoubtedly scatter through New Ontario. It is a work justifying the employment of the greatest experts in this line of work. No greater field of opportunity has ever been offered to the town planning expert and civic economist in this country. It is more than an opportunity, it is a sacred duty and responsibility confronting those whose eyes have been opened, and whose minds have been trained to see the need and feel the responsibility for the unborn towns of this great area. To those of you who know the North, there is no need to prophesy the birth of new communities. We can hear the sound of many hammers as the shacks spring up like a bed of mushrooms, and soon there will be the songs and laughter of many children. Shall the coming generation have no benefit from those who have so recently

gone before, and learned the hard lessons of the pioneer. Must they also learn from their own hard experiences all these lessons over again, or shall we turn and pause long enough to help guide them past these early pitfalls. There is no body of men better qualified by experience, sympathy and sense of responsibility than the Association of Ontario Land Surveyors, to consider the problem and to advise intelligently regarding its solution. There are those of our members who have given much time and thought to the question of town planning in its various phases, particularly as applied to the alteration of established communities, for the correction of past errors, most of which can be avoided, and at negligible cost in the lay-out of new towns. The problem of the development of new townsites in Northern Ontario is worthy of their attention; worthy of the attention of the biggest and brainiest men in many of the allied professions, the sanitary experts in the study of water supply and the disposal of waste; the medical health authorities in the study of the provisions for guarding and improving public health; the municipal finance experts in devising ways of providing the new towns at the earliest possible period, with the various civic necessities while protecting them from the over optimistic squanderer of public funds; the foremost educational authorities in planning for the future school population; the municipal legal experts in guarding them from piratical public service corporations. The best of what has already been learned in the older towns of the North, and of older Ontario should be accumulated, studied and applied as far as may be possible for the benefit of these towns yet to be.—Paper read at the Thirteenth Annual Meeting of the Association of Ontario Land Surveyors, Toronto, February 21-23, 1922.

SHORT COURSE IN WATER POWER DEVELOPMENT

LAST week's issue of "The Canadian Engineer" contained a short notice of the above-mentioned course and we are now able to give full details regarding this series of lectures. The lectures are to be given in room 22 of the Mining Building on College Street, University of Toronto, and have been arranged by the hydraulic section of the Department of Mechanical Engineering of the University of Toronto. Lectures are to begin each afternoon at 4:30 sharp. The lecture on Monday on "Hydraulic Turbines and Installation," was given by Lewis F. Moody, who is well acquainted with turbine design and kindred subjects. Mr. Moody is a graduate of the University of Pennsylvania, later a professor of Hydraulic Engineering in the Rensselaer Polytechnic Institute and is now consulting engineer with the L. P. Morris Co., Philadelphia, who are among the largest builders of hydraulic machinery in the world.

The lecture on Tuesday was given by Max V. Sauer, on "Hydraulic Equipment as Affecting Power House Design." Mr. Sauer is a graduate of the University of Toronto following which he spent some time on the University teaching staff. During the past twenty years he has been engaged in practical work with the Ontario Power Co., the Winnipeg Aqueduct and at present holds the position of hydraulic engineer of design with the Ontario Hydro-Electric Power Commission, having been in charge of the power houses on the Commission at Chippawa, Nipigon and other places.

On March 2 the subject of the lecture is "The Design of Power Canals, Headworks and Surge Tanks," the lecturer being Thomas H. Hogg, who graduated from the University of Toronto in 1907. Mr. Hogg has been connected with the power plants of Niagara Falls for a good many years. Subsequent to his connection with the Ontario Power Co. he was editor of "The Canadian Engineer" for three years, leaving that position to join the staff of the Hydro-Electric Power Commission of Ontario as associate hydraulic engineer and in that connection has played a prominent part in the design of all their plants including the Chippawa project.

On March 3, W. M. White, chief hydraulic engineer, of the Allis-Chalmers Co., Milwaukee, will deliver a lecture

on "Power House Machinery." Mr. White's name is a household word among those who are concerned with the design, construction and operation of this class of machinery, and his experience covers a great many years.

On March 6 at 4:30 p.m. Norman R. Gibson will speak on "Regulations and Testing of Hydro-Electric Machinery" and at 8:00 p.m. that same day he will deliver a lecture on "Some Economic Aspects of Hydro-Electric Power Development." Mr. Gibson, like Messrs. Hogg and Sauer, is a graduate of the University of Toronto and since leaving college has spent his entire engineering experience in water power developments in Ontario, Manitoba and Niagara Falls on both sides of the river. His name is well-known among hydraulic engineers throughout America.

The purpose of this symposium outlined above is particularly to bring the student into direct contact with the engineers responsible for the great hydraulic developments in America and to supplement the course in water power engineering and hydraulics now given and to give students a somewhat broader vision. This course will be of value to such men and it is hoped that a great many students will take advantage of it.

The University of Toronto is fortunate in securing a number of the most prominent engineers in America to give a brief course of lectures to students, and others interested, on the utilization of the vast water powers of this country. Five engineers are contributing to this lecture course, and each of them will deal with a phase of the subject in which he specializes, so that the whole field of water-power engineering will be treated from the viewpoint of the expert.

The University is giving regular courses in water power development and conservation at the present time, and has done so for many years, numbering amongst its graduates men who have become noted in this field of engineering. The present series will, therefore, supplement the regular courses and will bring the University into closer contact with the men who are responsible for the engineering work of the greatest water powers in America, and therefore the greatest in the world.

NEPTUNE METER CO., LIMITED, TO EXTEND TORONTO PLANT

WILLIAM H. RANDALL, managing director of the Neptune Meter Co., Ltd., Toronto, returned home recently after a trip to New York, where he placed orders for some special machinery with the object of extending the company's plant at 1197 King St. West, Toronto. For the past two years practically all of the company's standard makes of meters of the sizes that are usually in demand by Canadian municipalities have been manufactured in Toronto, but the large meters and all special types have been imported from the Neptune Meter Company's plant in the United States. "The object of the proposed extensions," says Mr. Randall, "is to enable the Canadian company to make practically all sizes and types for which there is likely to be any demand in Canada."

TOWN PLANNING BOARD FOR MONTREAL

IT IS probable that the Montreal City Council will appoint a town planning board which will be entrusted with the work of elaborating all projects which may tend to embellish the city such as the opening of boulevards. The city engineer declares that the board shall consist of five members, two of whom shall be the director of departments and the director of public works. The three other members shall be chosen from among the citizens and shall be appointed by a resolution of the council. A by-law will be adopted defining the powers of the board. The city charter further declares it shall also be the duty of the board to make to the council, without being requested to do so, any suggestion or recommendation it may deem useful or necessary in connection with the improvement of the city.

RAIL-CARBON STEEL DISCUSSED AT TORONTO BRANCH, E.I.C.

ONE of the most informing discussions held this season at the Toronto Branch of the Engineering Institute of Canada occurred on Thursday, February 16, when the subject of rail-carbon steel was presented by J. B. Carswell of the Carswell Construction Co., and discussed by the members. Mr. Carswell has recently had occasion to investigate the suitability of this material for concrete reinforcement, and presented the results of his inquiry to the meeting for its consideration in an illustrated address.

In the paper which will appear in an early issue of "The Canadian Engineer," the speaker took particular care to point out that this form of reinforcement is not properly re-rolled steel, but is rather reinforcement steel with a carbon content such as is found in railroad rails subjected to a continuation of the rolling that has already been given in rail manufacture.

In the discussion which followed Mr. Carswell's address, J. M. Oxley asked for further information concerning the origin of the rails and whether there was any certainty concerning the nature of the material that was being used. He cited a case where rail-carbon steel had been found very unsatisfactory and on inquiry had proved to be made from munition discards. He also knew of a case, some twenty years ago, where a railway company had rejected about 5,000 tons of rails as containing too high a phosphorus content and had often wondered whether such material might not have found its way into the manufacture of rail-carbon bars.

Effect of Brittleness

Mr. Oxley inquired as to whether cracking in rail-carbon bars due to brittleness would necessarily be followed by an immediate break. He thought that the bar might hold together for some time, as for example, a glass rod sometimes does after cracking, and later on rupture in the structure. He also wished to know the maximum and minimum variation from the average of the ninety tests of rail-carbon steel taken at random from the records of the rail steel mill. He thought that where but one test per ten tons of finished product, as required by the American Society for Testing Materials, was made, it might easily cover rails from more than one source and the single test might not disclose all possible defective material. He thought that the provision in the A. S. T. M. specification for a re-test in certain cases should be revised.

O. W. Ellis, of the Department of Metallurgy of the University of Toronto, stated that it was well known that segregation occurred chiefly in the centre of an ingot, which meant that when the ingot was rolled to a rail, the segregation would tend to occur principally at the base of the head. Rods rolled from the rail head would consequently contain most of the defective material, according to the speaker.

T. D. Mylrea on the whole substantiated Mr. Carswell's views with respect to rail-carbon steel. He cited the case of the behavior of steel in the damaging of concrete ships as an evidence of the cushioning effect of concrete. While a hole might be punched through the ship and the concrete shattered completely, the reinforcement rods were not broken. High carbon steel rods might consequently be used in such situations with safety.

R. O. Wynne-Roberts pointed out that in recent years the tendency has been to roll more open-hearth rails and that consequently the rail carbon steel industry will be using more material of that grade. He wished to know of the speaker what the effect on the output would be of this development in rail manufacture.

Ensuring Suitable Material

Mr. Carswell, in replying to the questions asked, stated that in the case of large orders for rail-carbon steel the purchaser could definitely ascertain the source of the rails used in filling this order. The inspection company could at

any time furnish information concerning the material, if necessary, and it would be possible to select certain definite types of rail to fill an order if such were absolutely necessary, although this would entail a great deal of extra work, and would add to the expense. The mills, he stated, turned over their yard output in a few months, and considering that railways renew their rails on an average every eleven years, it meant that the supply of rail-carbon steel at any time came from a rail rolled originally about twelve years previous. This would give, said Mr. Carswell, a rough guide to the type and composition of the rails used for the manufacture of the bars for a particular order.

The speaker stated that unfortunately a considerable quantity of munition discard material had been used in war time by the rail-carbon steel industry by special arrangement and with a view to helping out the economic situation. It had admittedly resulted in an unsatisfactory product and it was regrettable that such a step had ever been taken. It was hoped that the occasion for so doing would never arise again.

Referring to the 5,000 tons of rails rejected for high phosphorus content mentioned by Mr. Oxley, Mr. Carswell expressed the view that the use of such a large quantity of objectionable materials was not likely to occur in the rail-carbon steel industry of these days. He agreed that a single test for each ten tons of material did not seem enough and that the provisions for re-test should be revised.

Replying to Mr. Oxley concerning variations from the average tests, Mr. Carswell stated that the highest ultimate strength for the ninety tests of which reference had been made, was 109,000 lb. per sq. in. and the lowest 51,000 lb. per sq. in. Probably 90% of the test results ranged from 55,000 to 70,000 lb. per sq. in. The large sizes of bars, said the speaker, admittedly showed a drop in strength of about 7 or 8%. Consequently the manufacturers do not roll bars as a rule above about 1½ in. diameter.

Segregation

Mr. Carswell stated that when segregation occurred it was always worst at the end of the rail as rolled, or of the rods as completed, and the tests were always made on the first section cut from the end. If this showed defects, it was scrapped and the second section cut was tested, and so on until a point was reached where the rod was free from segregation or other defects. If cases of segregation eluded inspection, they would, if at all serious, show up in the rolls, for defective rails will jam the rolls and split. If it were not serious enough for that, then the amount of segregation in the final rod cross-section would be proportionately the same as that in the rail head, due to the nature of the rolling operation.

The speaker did not regard the increasing proportion of open-hearth rails as an argument against the rail-carbon steel industry. Such rails have been rolled for years with satisfactory results, and the high quality of the material undoubtedly results in satisfactory reinforcement bars.

Figures to show that the entire cost of the proposed international St. Lawrence waterway and power project could be defrayed by sales of electric current at prices cheaper than those at which current can be obtained at Niagara Falls, were presented by Henry L. Harriman, president of the New England Power Company, in an address recently before the Water Power League of America.

Messrs. Royce, Ltd., engineers of Trafford Park, Manchester, England, have received an order from Messrs. Braithwaite & Co. of West Bromwich and Newport, Mon., for the full equipment of 11 electrical overhead travelling cranes for workshops which Messrs. Braithwaite are erecting at Bombay, India. The workshops are being built in connection with a large order which the Braithwaite Company has secured for steel pipe 6 ft. in diameter and 114 miles long for supplying water to the city of Bombay.

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QUEENSTON-CHIPPAWA POWER DEVELOPMENT COSTS

APART from the hydro-radial issue, the chief matter of contention between the Ontario Government and the Hydro-Electric Power Commission appears to be the alleged excessive cost of the Chippawa development. It has not been represented, so far as we have been able to learn, that the work now partially completed are extravagant in character for the service demanded of them, or that they are needlessly permanent or that these structures, plant and equipment are not as simple and economical as sound engineering principles would require them to be in the circumstances. In all the criticism of the "Hydro" that has been voiced in Ontario, no one has been able to say that the engineering work, both in a large directive way and in detail, has not been entirely commendable. In our judgment, no more capable or loyal engineering organization was ever charged with a large project in this country.

The truth of the matter is that the Government with one eye on its precarious majority in the House and the other on the somewhat depressing financial situation in the province, has little desire to court unpopularity by effort to raise on its own responsibility further large sums for Hydro activities. It harbors a feeling, as Hydro critics in general do, that the Chippawa development is costing a lot of money, more by far than it was originally intended to spend, and that there must be something wrong somewhere. There surely must be waste or inefficiency somewhere, say the critics, or this could not have come about.

Let us consider the facts. According to Premier Drury's statement at Hamilton, the estimated cost of a 100,000-h.p. development in 1915 was \$10,500,000. In October, 1921, it was estimated by the Hydro-Electric Power Commission

that the cost for five units (275,000 h.p.) would be \$65,000,000. If the cost per horse-power be computed, it will be found to have grown in the estimates from \$105 in 1905 to \$256 in 1921. This seems a remarkable increase, but if the average value of the Engineering News-Record construction cost index number for the years 1917-1921, when the greater part of the Chippawa work was done be compared with that for 1915, when the original Hydro estimates were made, it will be found to be 2.21 times as great. Taking into account only the enhanced cost of materials and labor, without allowance for the known lessened efficiency of the latter during the period under consideration, the cost per horse-power developed should have grown to \$232, or practically the same as was estimated by Hydro for five units last autumn.

It is true that the Chippawa development cost has been high, but it has been the fault of the times, not of the engineering. Perhaps it should not have been carried out at all during the war and the post-war periods, but that was a large question of policy for which governments and not individuals must be held responsible.

EXPANSION AND CONTRACTION OF CONCRETE THROUGH MOISTURE VARIATION

TO the valuable studies already noted in our columns on the behavior of concrete due to temperature changes made by the Engineering Experiment Station of the University of Illinois, there has been added a helpful study of Torata Matsumoto on the effect of moisture content upon the expansion and contraction of plain and reinforced concrete, presented in Bulletin 126 of the Engineering Experiment Station.

According to Mr. Matsumoto, concrete expands when it absorbs moisture and contracts when it dries out in very much the same manner as wood. A concrete of a 1:2:4 mix is likely to contract during hardening as much as 0.05% in an ordinary structure. Such behavior results, of course, in stresses when the concrete is restrained by an external force. If the material be reinforced, the stress in the reinforcement may reach 16,000 to 18,000 lb. per sq. in. when the amount of reinforcement is less than 1½% and the shrinkage stress developed in the concrete may reach its ultimate tensile strength when the amount of reinforcement is greater than 1½%. The greater the percentage of reinforcement, the greater the tensile stress that may develop in the concrete, and concrete having a higher percentage reinforcement than 1½% is likely to have cracks form unless proper provision against them is made.

An interesting observation made by Mr. Matsumoto with respect to work done on the seaboard is that reinforced concrete does not appear likely to be a durable material in a place where a corrosive influence such as sea air is active, unless proper protection against the formation of shrinkage cracks and safeguarding of the steel is made. He suggests that this may be provided either by finding a cement giving less expansion and contraction, or by the use of a perfect water-proofing treatment. It is evident that there is much opportunity for further investigation and study in this particular to the end that structures along the sea-coast may be built of reinforced concrete without fear of disintegration of the reinforcement.

TOPOGRAPHY AND RAILWAY RATES

AN interesting chapter in railway history in Canada is recalled by the recent statement of Premier Oliver of British Columbia that by reason of the C.P.R. entering the mountains through the Klekling Horse Pass instead of the Yellow Head Pass, freight rates were 35% higher for British Columbia than for the rest of Canada. The federal government of that day favored the Yellow Head Pass, as the lowest summit in the range, but the C.P.R., fearful of competition from the United States, wished to run as close to the border as possible. A compromise was made whereby

the company agreed to cross at least 100 miles north of the border and to provide a gradient of not over 100 ft. to the mile. The Kicking Horse Pass was consequently adopted, but it was found impracticable to provide a grade better than 237 ft. to the mile against east bound traffic for about 8 miles, and on this section of line the subsidy could not be collected. Not till 1909, with the construction of the spiral tunnels between Hector and Field was this portion brought to approximately the standard originally demanded by the Government. On it the ruling maximum grade in the mountains, or 2.2% compensated, is now provided.

Apart from the historical aspects of the case, it is only fair that those portions of Canada which are less favorably situated in some respects than others should bear, in some measure at least, the disabilities incident to their geography. The cost of hauling traffic over unavoidably heavy grades cannot be made equal to that for hauling it over the prairies on tangent, any more than the price of Nova Scotia coal can be made the same in Ontario as it is in the province of origin.

PERSONALS

R. S. and W. S. LEA and W. T. FRANCIS have resigned from the Montreal Water Board but have been retained as consulting engineers.

ARTHUR ST. LAURENT, B.A.Sc., M.E.I.C., the recently appointed chief engineer of the Department of Public Works, Ottawa, was born at Rimouski in 1859. He graduated from the Ecole Polytechnique, Montreal, in 1885 and was engaged upon the location and construction of the Temiscouata Railway for three years. Entering the Public Works Department in 1888, he was assistant engineer at the district office at Winnipeg until 1898. Mr. St. Laurent was entrusted with the work of constructing the concrete bridge over the Saskatchewan River at Edmonton in 1900. He designed the lock and dam at St. Andrews in the Red River, north of Winnipeg, and constructed the Laurier Avenue bridge at Ottawa, and the government grain elevator at Montreal. When the construction of the Georgian Bay Canal was first considered, he conducted the topographical survey. In 1908 Mr. St. Laurent was appointed assistant deputy minister of Public Works and in that capacity has been concerned with extensive navigation schemes, harbors and drydocks, besides acting as vice-chairman of the Dominion Water Power Board. Mr. St. Laurent is a member of the Engineering Institute of Canada, of which he was for three years vice-president, member of American Society of Civil Engineers, the International Navigation Congress and the Civil Service Board of Hearing and Recommendation. He was chairman of the Ottawa Branch of the Engineering Institute of Canada in 1914.

GERALD POWER, who was recently appointed president of the Quebec Harbor Commission, was born in Silvery in 1882. He was educated at Mont St. Louis College, Montreal, and later was engaged with the Riviere Ouelle

Pulp & Lumber Co. He is an ex-president of the Canadian Pulp & Paper Association and is now president of the Peninsula Lumber Co.

EDWARD M. PROCTOR, of the firm of James, Proctor & Redfern, Ltd., consulting engineers, Toronto, has returned home after a three months' trip to the Barbados and Central America.

S. FORTIN, assistant director of public works, has been appointed City Surveyor of Montreal, which was the title of that branch of the civic service before the organization of the public works department. By his appointment as city surveyor, Mr. Fortin is duly authorized to sign the official plans of the department, as required by law.

THOMAS ADAMS, of the Dominion Parks Branch, Ottawa, has returned home after a five months' visit to England where he has been associated with Thomas Mawson, the famous landscape architect, in town planning work in London, Northampton, Windermere, Blackpool and other cities and towns. Mr. Adams has just started a course of lectures on town planning at the Massachusetts Institute of Technology, and in the department of Landscape Architecture at Harvard University.

ROGER DEL. FRENCH, professor of highway and municipal engineering, McGill University, Montreal, has issued an announcement that he will accept a limited number of consulting engagements in connection with water supply and sewerage systems, roads and pavements and reinforced concrete structures. Prof. French was a member of the staff of R. S. & W. S. Lea, consulting engineers, Montreal, for nearly ten years, resigning a few years ago to become a member of the firm of Arthur Surveyer & Co., consulting engineers, Montreal. He resigned from the latter firm in order to accept appointment as engineer for the Lignite Utilization Board. Upon completion of the Board's briquetting plant in Saskatchewan, he accepted the chair in the McGill department with which he had been previously connected for a number of years as a part-time lecturer.

FREDERICK W. COWIE, B.A.Sc., M.E.I.C., has resigned from the position of chief engineer of the Montreal Harbor Commission after 36 years service, and has been appointed consulting engineer to the Board. Mr. Cowie graduated from McGill University in 1886 and the same year joined the staff of the Montreal Harbor Commission under Sir John Kennedy, the chief engineer. For the next twenty years Mr. Cowie was directly connected with the St. Lawrence ship channel and is now one of the leading authorities in Canada on river hydraulics, dredging and navigation improvements. In 1907 Mr. Cowie was appointed chief engineer of the Commission upon the retirement of Sir John Kennedy, who was made consulting engineer. During the last fifteen years most important improvements have been made to the harbor and plans formulated by Mr. Cowie in 1909 have been almost completed, the result being that Montreal has one of the most modern harbors in the world. Mr. Cowie was awarded the Telford medal in 1914 by the Institute of Civil Engineers, London, England. He has been a full member of the Engineering Institute of Canada since 1898.

NEW PUBLICATIONS

MULTI-JET CONDENSING plants are described and illustrated in a bulletin No. 1028 issued by the Canadian Ingersoll-Rand Co., Sherbrooke, Que. The principal features of this type of condenser are dealt with and illustrations show the interior construction. Copies may be had on application to the head office or any branch of the company.

THE U. S. BUREAU OF MINES reports that R. Van A. Mills is continuing his study of the action of water on oil and gas strata and has gathered information of exceptional value to oil producers in handling wells that are troubled by deposits of asphaltic residues or salts. Mr. Mills has pointed out the ways in which water can harm oil wells and is now preparing a bulletin on the subject.



CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Huntsville, Ont., construction of pavement	Mar. 1	Jan. 31
Glenboro, Man., erection of a school	Mar. 1	Feb. 14
Kitchener, Ont., erection of school annex	Mar. 3	Feb. 14
Saskatoon, Sask., supply of generator and turbine	Mar. 6	Feb. 7
Burlington, Ont., erection of a school	Mar. 6	Feb. 7
Ontario, Province of, construction of pavements, culverts, grading, etc.	Mar. 6	Jan. 31

BRIDGES, ROADS AND STREETS

Coquitlam, B.C.—Tenders have been called by the Canadian Pacific Railway Co. for the construction of a new bridge across the Coquitlam River. Steel construction with concrete piers.

Islington, Ont.—Etobicoke Township Council authorized the widening of Scarlett Road. Clerk, Stephen Barratt, Islington.

London, Ont.—The question of the advisability of erecting a bridge over the river at Richmond St. will be considered by the City Council. City Engineer, H. A. Brazier.

Niagara Falls, Ont.—The Provincial Department plans the immediate construction of a steel arch type bridge over the Hydro canal at Lundy's Lane. The Department also plans to let contracts in March for six miles of concrete pavement from Bridge St. at Fairview cemetery to St. David's.

Ontario, Province of.—A deputation from the towns of Smith's Falls, St. Mary's, Trenton and Ingersoll waited on Hon. F. C. Biggs, minister of public works, urging that these municipalities be given provincial grants as connecting links of the Windsor to Montreal provincial highways.

Ottawa, Ont.—George Hogarth, chief engineer of the Department of Public Highways, Ontario, announced recently that the Ottawa-Prescott highway would be permanently surfaced from the city limits to Hogg's Back, a distance of over two miles, and also that the missing two miles of pavement on the Ottawa-Point Fortune road a few miles out of Ottawa will be built in the early part of the coming summer.

Sherbrooke, Que.—The City Council passed a by-law authorizing the raising of \$55,000 for the construction of Dufferin Bridge. The bridge will be of concrete and steel construction.

Sherbrooke, Que.—The City Council passed a by-law authorizing the raising of \$200,000, of which \$175,000 is for sidewalks and \$25,000 for the viaduct on Ganit St. Another by-law was passed authorizing the raising of \$75,000, of which \$20,000 is for the levelling of King St. West, and \$55,000 for the paving of King St. West.

Toronto, Ont.—The City Council sent back a recommendation of the Works Committee to construct a new asphalt pavement on Bathurst St., from College to Dupont Streets.

Toronto, Ont.—Ratepayers of the portion of Runnymede recently annexed to the city decided to petition the

Board of Control for a concrete pavement 28 ft. wide on Runnymede Road.

Toronto, Ont.—The City Council instructed Works Commissioner Harris to include in the 1923 estimates \$312,000 for the straightening of Gerrard St., from Logan Ave. to Pape Ave.

Victoria, B.C.—The City Council will have a committee confer with the Victoria West Brotherhood regarding the latter organization's plan to bridge Victoria Arm.

WATER, SEWAGE AND REFUSE

Burlington, Ont.—The Burlington Beach Commission passed a by-law providing for the raising of \$30,000 for the extension of the water works system and connecting same with the water works system of the city of Hamilton. Clerk, M. H. Carroll.

Kingston, Ont.—The City Council passed a by-law providing for the construction of a sewer and 6-in. water main in Regent St. from Johnson to Park St., and Dundas St., from Macdonnell to Regent St. Estimated cost, \$24,256.66. Clerk, W. W. Sands, M.D.

Mimico, Ont.—A complete water system for a district north of Mimico, comprising about 13 acres, was authorized at a recent hearing before the Ontario Railway and Municipal Board, at which the Etobicoke Township Council presented the application.

Montreal, Que.—Ald. J. N. Sansregret has asked the executive committee of the City Council to authorize the laying of sewers in several portions of Delorimier Ward. The executive committee has referred the demands to S. Fortin, assistant director of public works, for an estimate of the cost.

Montreal, Que.—The list of streets on which sewers will be laid in the north end of the city is as follows: Birnam St., from Beaumont St. to Cremazie Boulevard, \$65,000; Stuart St., from Cremazie Boulevard to Beaumont St., \$65,000; Lanorlie St., from Abraham St. to Cremazie Boulevard, \$42,000; Allan St., from Ball St. to Ogilvie St., \$16,550; Anvers St., from St. Adele St. to Lanoraie St., \$3,553; Ogilvie St., from Lanoraie St. to Stuart St., and from Birnam St. to Allan St., \$3,430.

Niagara Falls, Ont.—The City Council intends to construct the following sanitary sewers: McRae St., from Slater Ave. to lot 157, \$4,636.68; Florence Ave., from McRae St. to Stamford St., \$3,207.25; Stamford St., from Florence to Burn, \$4,354.86; McDonald Ave., from Stamford to Kitchener, \$2,134.70; Kitchener St., McDonald to Powell, \$2,558.92. City Clerk, W. J. Seymour.

Peterboro, Ont.—The City Council intends to construct a sewer on Rogers St. City Engineer, R. H. Parsons.

Peterboro, Ont.—City Engineer R. H. Parsons will report to the Board of Works on the cost of a sewerage system for the Engleburn district of the east end of the city.

Sherbrooke, Que.—The City Council passed a by-law authorizing the raising of \$120,000 for sewers.

Toronto, Ont.—The City Council approved of the transfer of 4.2 acres of land at the old cattle market to the street cleaning department for use as a site for a garbage destructor.

Woodbridge, Ont.—At a recent meeting held here Engineer E. A. James, Toronto, presented plans and estimates for a water system. It is proposed to obtain the water from wells. The system would at first include only the business centre and the main streets of the village, but the plant would be large enough to provide for extensions. The cost

of a partial distribution plant, pumping station, standpipe and wells was estimated at between \$25,000 and \$30,000.

LIGHT, HEAT AND POWER

London, Ont.—A definite decision to take immediate action on the plan of Mayor J. C. Wilson to build a new dam in the Thames river at Springbank was reached by the City Council. Application will be made to the Legislature to validate a bond issue of \$140,000, and the Public Utilities Commission will be authorized to proceed with the work.

Port Perry, Ont.—It is expected that Hydro will be extended to Port Perry by next September. Power will be brought from Cannington. At Greenbank the power line will split, one branch going to Uxbridge and the other to Port Perry.

St. Thomas, Ont.—The City Council passed a by-law authorizing the raising of \$15,000 for the purchase of transformers.

RAILWAYS

Edmonton, Alta.—Premier Herbert Greenfield announced that further extensions to the Lacombe and North Western Railway, owned and operated by the Provincial Government, will be made this year.

Galt, Ont.—A resolution calling for the electrification of the Galt-Elmira branch of the G.T.R. system of Hydro radials was passed at a recent meeting held in this city of representatives of municipalities along the line.

Toronto, Ont.—The City Council passed a resolution requesting the Provincial Government to permit the immediate construction of the Toronto-Port Credit Hydro-radial Railway.

Windsor, Ont.—Plans for the construction of the new C.P.R. freight sheds and tracks have been completed. Address F. M. Rutter, superintendent of the London Division, C.P.R.

Windsor, Ont.—It is reported here that the Ontario Hydro-Electric Power Commission contemplates taking over the Pere Marquette, the Windsor, Essex & Lake Shore, and the Chatham, Wallaceburg & Lake Erie Railway. In this event the Pere Marquette Railway would be electrified.

FACTORIES AND LARGE BUILDINGS

Assiniboia, Sask.—Plans and specifications for an addition to the school, estimated to cost \$15,000, have been secured by the trustee board. Secretary, J. B. Smith.

Athens, Ont.—The Athens High School Board instructed A. S. Allaster, Brockville, to prepare plans and specifications for the reconstruction of the High School.

Bathurst, N.B.—The Bathurst Lumber Co. is proposing the erection of a ground-wood pulp mill at a cost of approximately \$550,000. Angus McLean is president and general manager. William Kennedy, Jr., 364 University St., Montreal, is consulting engineer.

Birchcliffe Heights, Ont.—The Sons of England will erect a hall, as also will the G. W. V. A.

Birchcliff, Ont.—The High School Board decided to erect a High School at Stop 29, Kingston Road, at a cost of \$125,000.

Birchcliffe, Ont.—Scarboro Township Council issued debentures amounting to \$60,000 for the erection of a school.

Blenheim, Ont.—Dr. Mills, provincial inspector of continuation schools, has recommended the erection of a four-room high school here.

Bolton, Ont.—Robert Caldwell has been authorized to prepare plans for the rebuilding of the Town Hall.

Brampton, Ont.—Improvements estimated to cost \$34,500 are planned to Peel County Memorial Hospital.

Campbellford, Ont.—Tenders for the erection of a High School will be received until March 7 by S. B. Coon & Son, Architects, 4 St. Thomas St., Toronto.

Cooksville, Ont.—The Centre Road Community Association plans the erection of a school. President, W. R. Wadsworth.

Courtenay, B.C.—The machine shops of the Comox Logging Co., near here, were almost totally destroyed by fire recently. The shops were equipped with machinery valued at about \$50,000.

Edmonton, Alta.—The trustees of Westminster Ladies' College plan the erection of a college building at a cost of \$25,000.

Edmonton, Alta.—Estimates for a new Isolation Hospital will be discussed by the city board of health. In all likelihood, the board will decide to inform the City Council that the sum of \$125,000 proposed is too small and that a larger amount should be raised.

Elmira, Ont.—The ratepayers of School Section No. 6 of Peel, Wellington County, decided to build a public school next summer. Tenders will be called.

Elmsdale, N.S.—The Nova Scotia Clay Works, Ltd., decided to add two new kilns to their brickmaking plant.

Fort William, Ont.—The Great Lakes Pulp & Paper Co. will spend \$2,000,000 on a paper mill here within three years, their time for so doing having been extended by a year.

Fraserville, Ont.—The erection of a new station is projected.

Fredericton, N. B.—At a cost of approximately \$25,000 Cathedral Memorial Hall will be erected next summer. Plans for the building were prepared by Delancy Robinson, of New York, and tenders will be called for shortly.

Galt, Ont.—The International Tank and Silo Co., Ltd., will erect a plant in this city shortly. Edward Stuart, of Toronto, and John Murphy, of Winnipeg, are chief partners in the company.

Greencourt, Alta.—The Gillespie Elevator Co. plans the erection of a grain elevator here this spring.

Haney, B.C.—The erection of a High School is projected.

Hamilton, Ont.—The Centenary and Charlton Avenue Methodist Churches are considering a plan to amalgamate and erect a new church at an estimated cost of \$500,000.

Hamilton, Ont.—The City Council will submit a by-law to the ratepayers to provide a free site and a substantial sum toward the cost of the buildings in connection with the proposed removal of McMaster University from Toronto to Hamilton.

Humber Bay, Ont.—The ratepayers authorized an issue of debentures amounting to \$90,000 for an addition and equipment for the Humber Bay School.

Kitchener, Ont.—A permit has been issued to the Kitchener Motor Sales Co., 126 King St. East, for the erection of a motor sales building at a cost of \$18,000.

Kitchener, Ont.—The City Council endorsed the finance committee's suggestion that a by-law be prepared authorizing the building and equipping of a Collegiate and Vocational School, of which Kitchener's share is not to exceed \$225,000. The entire cost of the school is estimated at \$490,000. The Town Council of Waterloo, which municipality will figure jointly in the Collegiate with Kitchener, have already passed in favor of their share.

Lethbridge, Ont.—A site for a new church on the corner of Fifth Ave. and Eleventh St. has been purchased by the Christian Church. Pastor, Rev. Mr. Howard.

London, Ont.—The establishment of a High School in Middlesex County is proposed.

London, Ont.—The members of St. Patrick's Church, Dundas St., decided to erect an addition to the building.

London, Ont.—The city is now asking the Legislature for authority to issue debentures amounting to \$250,000 for Western University.

London, Ont.—The Board of Education decided upon a building program for this year entailing an expenditure of approximately \$700,000. A branch collegiate is to be erected in South London at a cost of about \$220,000, a school to replace Empress Ave. in West London will cost about \$195,000, including the site; another new school in

the Ealing district, on the corner of Dakin, and Price streets, will cost \$82,000; and an auditorium, gymnasium and additional classrooms for the Technical and Arts School will cost \$120,000.

Melbourne, Ont.—The ratepayers decided to erect a four-room school.

Mildmay, Ont.—Trustees of public school section No. 3, Carriek, plan the erection of a brick school next summer, at a cost of \$6,000.

Montreal, Que.—E. Z. Trudel has been appointed as architect in connection with the erection of the proposed new Homeopathic Hospital. Estimated cost, \$225,000.

New Toronto, Ont.—The School Board plans the erection of a four-room school.

New Toronto, Ont.—The School Board has requested the Town Council to supply funds for the erection of a school.

Niagara Falls, Ont.—Fire damaged the crusher house and bins of the Queenston Quarry, Ltd., at St. David's to the extent of \$10,000.

Oshawa, Ont.—Fire destroyed the Thornton Rubber Factory, the loss being estimated at \$100,000. Owners, Morson, Boswell Co., 64 Wellington St., Toronto.

Ottawa, Ont.—Application will be made to the Legislature for authority to raise \$30,000 for repairs and alterations to the Fire Stations and the City Hall.

Ottawa, Ont.—The Hamilton Tar Products Co., Ltd., of Hamilton, Ont., are erecting a plant here for refining tar for road building and roofing purposes and for the recovery of by-products.

Ottawa, Ont.—The wholesale grocery warehouse owned and occupied by John Dover & Son, at 21-23 York St., was practically destroyed by fire. The building was valued at about \$25,000.

Owen Sound, Ont.—Fire on Feb. 17 destroyed the Kilbourn Block, the loss being estimated at \$40,000 for the building alone. The building was occupied by W. T. Harris & Co., Wholesale Grocers, the Kilbourn Estate and the Empire Store Co.

Pembroke, Ont.—The erection of a new building next summer to replace the present Cottage Hospital is projected.

Port Arthur, Ont.—A permit has been issued for the construction of an elevator by Parrish and Heinbecker, of Winnipeg, on the Port Arthur water front. The permit calls for an all-concrete building with a capacity of 250,000 bushels.

Port Colborne, Ont.—Fire destroyed a warehouse of the Maple Leaf Milling Co., used by the Ontario Bag Co.

Port Stanley, Ont.—Tenders will be called immediately for the construction of a dancing pavilion for the London & Port Stanley Railway Co.

Quebec, Que.—Arrangements have practically been made by the Quebec Harbor Commission with Allan C. McAvity, of St. John, N.B., for the erection and operation of an oil fuel plant in Quebec similar to the plants now in operation at Halifax and St. John.

Quebec, Que.—Excavation was started here last week for a 23-storey addition to the Chateau Frontenac. This block will rise in the centre of the quadrangle now formed by the hotel, and will take the form of a huge tower. Anglin-Norcross, Ltd., Montreal, have the general contract, and the Dominion Bridge Co., Ltd., have the contract for the structural steel.

Ranfurly, Alta.—The erection of a school is projected.

Ste. Marguerite Du Lac, Masson, Que.—The parish church of this village and the convent of the Sisters of Providence were destroyed by fire. Estimated cost, \$80,000.

St. Mary's, Ont.—The Verdun Club plans the erection of a clubroom and gymnasium. Address W. N. Harrison.

Silverthorne, Ont.—The ratepayers decided to authorize the public school trustees of S. S. 35 to issue debentures amounting to \$21,000, for the purpose of a school site and for the erection of four temporary rooms.

Smith's Falls, Ont.—The members of Westminster Presbyterian Church plan the erection of a new church.

Stratford, Ont.—The Board of Education approved the tender of John L. Youngs for the construction of a four-

room addition to Hamlet Ward School, at a cost of \$41,975.

Stratford, Ont.—The Board of Education approved the tender of John L. Yonge for the construction of a four-room addition to Hamlet Ward School, at a cost of \$41,975. The Board is also considering the provision of additional accommodation in Shakespeare Ward.

Streetsville, Ont.—The Public School Board is considering the erection of a four-roomed school. Estimated cost, \$50,000. Chairman, J. H. Atkinson.

Sudbury, Ont.—The Salvation Army plan the erection of a barracks at a cost of \$15,000.

Sudbury, Ont.—Revillon Freres plan the erection of a two-storey building on Station St.

Sudbury, Ont.—J. A. Holmes plans the erection of block this spring. D. L. McKinnon & Sons will also erect a new block.

Sudbury, Ont.—The Sudbury Separate School Board have called for tenders for a 4-roomed school to be erected at a cost of \$40,000.

Sudbury, Ont.—Plans have been prepared for the proposed new Regent Theatre, and work will start in the spring. Manager, Mr. Stevens.

Thorold, Ont.—A by-law will be submitted to the ratepayers to provide \$60,000 for additional High School accommodation.

Toronto, Ont.—The Board of Education will call for tenders at once for the construction of the new McMurrich and Kimberley Schools.

Toronto, Ont.—The Separate School Board will break ground this week for the erection of a school on Jane St. north of Bloor St.

Toronto, Ont.—The Merrill Building System will construct a \$125,000, electrically equipped apartment house at Earl and Jarvis Streets.

Toronto, Ont.—A campaign for a new \$100,000 home for the Humane Society may be started next June, Manager J. W. Wilson announced.

Toronto, Ont.—The erection of a six-storey physicians and surgeons building at 86 Bloor St. West is projected. Address H. Addison Johnston.

Toronto, Ont.—The members of Danforth Ave. Methodist Church considering the erection of an addition to the church. Pastor, Rev. J. J. Coulter.

Toronto, Ont.—Monarch Park Highways' and Business Men's Association are considering the erection of a Community Hall near Coxwell and Danforth Avenues.

Toronto, Ont.—It is expected that tenders will be called for by the Board of Education for the erection of the East End branch technical school in two weeks' time.

Toronto, Ont.—The Board of Education will prepare plans and call for tenders for the addition of four classrooms at Givens St. School. Estimated cost, \$50,000.

Toronto, Ont.—Business Administrator W. W. Pearce will report to the Board of Education on the provision of additional accommodation for Ryerson, Brant and Manning Schools.

Toronto, Ont.—A permit was issued to the Separate School Board for the erection of a two-storey brick school on the southwest corner of Clifton road and Garfield Ave., at a cost of \$60,000.

Toronto, Ont.—The Board of Control approved of the project to erect a civic stadium to be known as "The War Memorial Stadium." The Sportsmen's Patriotic Association estimates the cost at \$150,000.

Toronto, Ont.—The board of managers of Christ Church has purchased the northwest corner of Lawton Boulevard and Heath St., and will commence building a new church and parish house shortly.

Toronto, Ont.—The erection of four stores with two five-roomed apartments above each, involving a total of close to \$100,000, on a site 38 by 100 ft., at the corner of Lansmore Crescent and Danforth Ave., is planned by Andrew Simone and Vito Leo, fruit dealers.

Toronto, Ont.—Excavation work has started for the erection of a 16-room separate school on McDonnell Sq. which will cost about \$150,000. The Separate School

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Municipal Asphalt Plant at St. Catharines, Ont.

Description of Hetherington & Berner Paving Plant—Will Turn Out 100 Sq. Yards of 2-in. Surface per Hour—Economies Effected in Operation — Facilitates Handling of Materials

By W. P. Near, B.A.Sc.,
City Engineer

DURING the year 1921 the city of St. Catharines joined the growing group of Ontario municipalities who now own and operate their own asphalt paving plants which enables them to not only make the necessary repairs to existing asphaltic pavements but also to construct new pavement surfaces at a more economical cost than under the contract system where more expensive portable asphalt plants are used. Tenders were called March 17, 1921, and the contract for the plant was awarded to Hetherington & Berner of Indianapolis. The contract called for completed erection by June 30 and the plant was put in operation in July. As there were some unusual features in the arrangement of the units a description of the plant may be of interest at the present time.

The main plant is the standard semi-portable type built by Hetherington and Berner to turn out 100 sq. yds. of 2-in. surface per hour and various units are designed accordingly.

Sand Dryer Unit

The sand dryer is of 8 ton capacity having a rotary drum 42 in. in diameter and 16 ft. in length. The drum is fitted with spiral flights to carry the sand through the drum, and box sections to elevate and drop sand through the hot blast. The dryer is equipped with a fuel oil burner ("Best" type) and also grate bars for coal burning; the change from fuel oil burning to coal grates may be made in half an hour's time. The dryer rests on a brick foundation 20 in. above grade of yard and hence permits of easy firing when coal is used. The fuel oil burner was used throughout the season and was found to be most effective as well as economical. The regulation of the heat is easily controlled and in case of a shut down of the plant, the heat may be shut off immediately and thus prevent any danger of the dryer becoming overheated.

The fuel oil is supplied from a 100 gallon tank on top of the dryer housing and the oil is steam heated and fed by steam pressure. A 600 gallon tank from an old sprinkling wagon is located adjacent to the dryer foundation and used

for fuel oil storage, and a steam ejector charges the 100 gallon tank from the storage. The 100 gal. feed tank should be larger, say 150 or 200 gallon capacity, to hold a supply of fuel oil sufficient for half a day. It is necessary to shut down the burner to charge the feed tank and the smaller tank necessitates a delay of a few minutes in the plant operation morning and afternoon which could be obviated by increasing its capacity.

The fuel oil burning has an advantage in that the dryer can be raised to proper temperature in 15 minutes time when starting up the plant in the morning whereas coal firing requires two hours or more and an extra fireman

Asphalt Melting Plant

The kettle unit consists of one stationary steam melting tank of 12 tons capacity or a quantity sufficient for a run of nine hours without refilling. Steam melting is used to avoid the possibility of burning or coking the asphalt. The kettle is built so that asphalt from barrels or tank cars may be used. An asphalt reservoir of 18,000 gallons capacity fitted up with steam coils on bottom of tank is built underground. This permits the asphalt from the tank car to flow by gravity

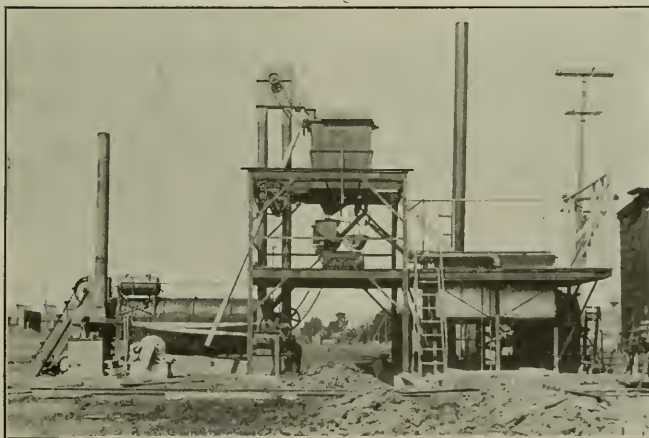
to the reservoir where it is kept at about 210 degrees Fah. An air lift system is located in a pit so that the receiver is below the bottom of the asphalt reservoir and by means of this air lift and arrangement of valves, the following operations of lifting the asphalt are carried out.

1. The melting kettle may be charged from the asphalt reservoir. This operation is carried out at the end of a day's run and the kettle is then heated by steam during the night and is ready for operation in the morning.

2. The asphalt is discharged from the melting kettle to the asphalt bucket on the weighing scales during the day's operations.

3. The asphalt may be discharged direct from the reservoir to the weighing bucket.

Difficulty was experienced with the first tank car of



GENERAL VIEW OF PLANT

asphalt emptied into the reservoir. A heavy rain storm caused water to get in the reservoir and made the hot asphalt foam. It was then discovered that water was seeping through the wall of the reservoir at the corner of the boiler house. The wall here was uncovered and plastered on the

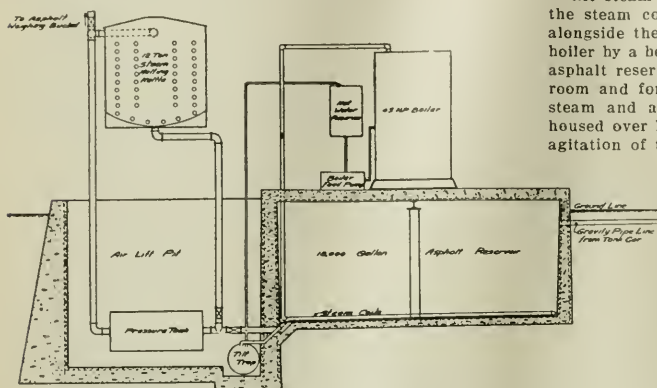


FIG. 2—SECTION THROUGH ASPHALT RESERVOIR, AIR LIFT PIT AND STEAM MELTING KETTLE

outside, and there was no further trouble from this cause. However the foaming of the asphalt caused such serious interference with the plant operation that an auxiliary asphalt pump was installed so that asphalt could be pumped direct from the tank car to the melting kettle in case of trouble from water in the asphalt reservoir. However, it has not been necessary to use this auxiliary pump.

The asphalt reservoir permits the buying of asphalt in tank cars instead of packages at a considerable saving in first cost. It also eliminates the elevating and handling of barrels into the kettle. It permits of the storage of nearly three tank cars of asphalt and the immediate unloading of the car resulting in saving demurrage charges. Several tank cars were placed, heated, discharged and shipped out in 24 hours.

The Mixing Unit.

The asphalt lift consists of a Westinghouse air compressor, air receiver tank and asphalt lift tank. The lift tank and all pipes and valves which handle hot asphalt are steam jacketted.

The hot material elevator delivers the hot mineral aggregate from the discharge chute of the sand dryer to a rotary screen mounted in the top of the sand bin and provided with two sizes of screen for sand and $\frac{3}{8}$ -in. stone. The hot material storage bin which has a total capacity of 9 tons, is divided into two compartments suitably proportioned for sand and stone, and is provided with tallings chute and overflow chute.

The sand and stone weighing box has a capacity of 10 cu. ft. and rests upon a 2000 lb. platform scales having three beams, one each for sand, stone and dust. All beams are enclosed in a dust proof casing and are supplied with an outside indicator and beam triggers.

The asphalt weighing bucket has a capacity of 2 1/3 cu. ft. and is suspended from a scale having a capacity of 625 lbs. The bucket is charged with asphalt from the air lift tank and by a trolley arrangement is propelled over the mixer where it is discharged. The mixer which is steam jacketted has a capacity of 9 cu. ft. sufficient to take a 1100 lbs. batch and is of the two shaft pug-mill type. The gate of the mixer is of the rack and pinion type and is operated by a hand wheel. The mixer floor is 10 ft. above the grade level of roadway which permits ample clearance on the driveway for waggons or trucks.

The plant is driven by a 30 h.p. 550 volt motor with the exception of the Westinghouse air compressor and the emergency asphalt pump which are operated by steam. A 45 h.p. vertical boiler supplies the steam for the steam melting, steam jacketted pipe lines, tank car heating, etc. A tilt steam trap returns the water of condensation from the steam coils and steam jacketted pipes to a reservoir alongside the boiler and this hot water is returned to the boiler by a boiler feed pump. A floor slab over half of the asphalt reservoir is used for the boiler and air compressor room and forms a convenient and compact layout for the steam and air lines. The other half of the reservoir is housed over but is arranged with ventilators and doors for agitation of the asphalt in case of foaming.

Plant and Yard Lay-Out

The site for the plant was chosen in a Y between two railroad sidings and the layout has proven to be most economical from an operation point of view. It is possible to have a car of each of seven materials placed properly for unloading at the same time, viz.: stone dust, fine sand, medium sand, $\frac{3}{8}$ in. stone, screenings, coal and asphalt. The cold material elevator is placed on the end of the dryer and all of the ingredients are located at short range so that they may be shovelled or wheeled in barrows to the elevator. The stone dust shed is located so that the dust may be unloaded readily from a car for storage or carried direct from the car to the plant or from the storage to the plant. The job crane hoist on the kettle floor of the plant designed to hoist the barrels of asphalt is used to elevate the bags of stone dust to the mixer floor. The office is so located that the windows command a view of the cold material elevator and the driveway through the plant thus enabling the inspector to check the feed of the elevator and the batches and loads through the plant. Fig. 3 shows the location of the asphalt reservoir with boiler house above, and of the auxiliary asphalt pump and pipe line to the other siding. The fuel oil storage is placed alongside the dryer and immediately below the feed tank. The motor has a separate house to exclude dust. The whole plant is housed in a corrugated iron building and designed to provide ventilation in summer time and to be readily closed in when the plant is not in use. The total cost of the whole plant including 7 ton tandem roller, fire waggon and all tools for street work was \$33,000.

The plant was used to construct 30,000 sq. yds. of 2-in. stone filled sheet asphalt during the season and showed a larger capacity than 100 sq. yds. per hour. During a nine hour day 1057 sq. yds. of 2-in. surface was turned out.

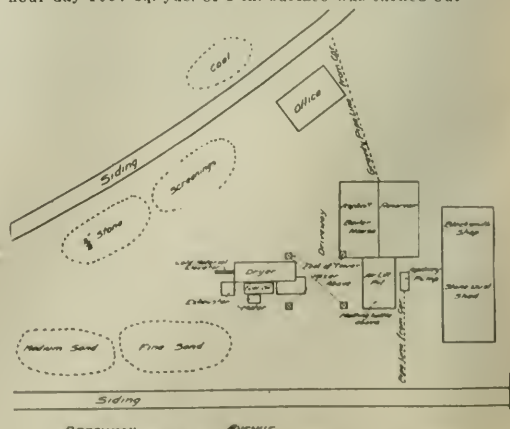


FIG. 3—PLAN SHOWING LAY OUT OF PLANT

CHARACTERISTICS OF RAIL-CARBON STEEL*

Manufacture, Qualities and Uses as Reinforcement Bars — Rail Steel a Reliable Material — Cushioning of Concrete Precludes Rupture of Bars by Shock

By J. B. Carswell

President, Carswell Construction Co., Toronto

IN DISCUSSING the qualities and uses of rail-carbon steel bars as used in reinforced concrete structures, let us, in so far as it is humanly possible, lay aside for an hour at least, all the prejudices and enthusiasms we may have on the subject and approach the question with an absolutely open mind. Let us lay aside at the same time, all the secondary evidence which seems to be so prolific when this question is discussed; all the statements about poor material which somebody else encountered; about bars that broke on some other engineer's job; about the difficulties some one else had in bending bars; and if we do this, I think we will be surprised at the small amount of real adverse evidence that remains.

Source of Material

In studying this subject, the first question is naturally as to the origin or birth of the rail-carbon bar. When the rolling stock on steam railroads began to increase rapidly in size and weight, the wearing quality and strength of the rail became increasingly important. Engineers were soon looking round for a material that would withstand the wear; that would withstand vibration, and would withstand the sudden impact at 40 deg. below or 100 deg. above. The modern rail is the result of years of such investigation, composed of super-refined steel with a high carbon content, which carries with it a certain amount of brittleness, yet ductile enough to withstand the pounding and vibration of a modern locomotive flashing over it; a steel which is hard enough, not only on the surface, but right through its structure, to stand up against the grinding action of the wheels when a train is brought to rest, a quality which again carries with it a high elastic limit.

Such is the rail being sold today; such is the rail with perhaps a little less refinement that was sold 15 or 20 years ago, and such is the material from which rail steel bars are rolled.

The second aspect of the subject also starts away back some 30 years ago when reinforced concrete structures began to appear. Up to this time, practically all structural work was carried out with steel framing, and one of the essentials in the material for a steel shape was, and still is, ductility or toughness. Nothing but a tough material could stand up to the punching and shearing in the steel fabricating shop; nothing but a tough material should be used in a lattice steel railroad bridge subject to intense shocks and vibrations.

Therefore, when engineers started out on the design of reinforced concrete structures, it was natural that they should follow the same specifications for their steel—a specification which had stood them in good stead for many years, a specification which was safe and conservative, that is, a mild steel specification. No criticism can be offered or the engineers so doing, because very little was then known about what was happening inside that combined steel and concrete girder; in fact to-day, after 30 years' research, the subject is by no means exhausted.

Cushioning Effect of Concrete

But to-day certain things have been proved about reinforced concrete, and proved beyond any further doubt, and the first is, that unlike a steel structure, no external stress can reach an individual rod, and no external stress can reach a group of rods in 100% intensity. I have a feeling that many engineers do not quite realize the importance of that phase of reinforced concrete design. To my mind, it is akin to the change in practice in life insurance com-

panies. If my father had insured his life for \$100,000, one company would have carried the policy and would have stood the whole stress of payment, but today if I insured my life for this amount, the policy would be divided up among probably 30 companies. It is just the same in concrete work, the bars work in teams.

The second is that concrete has a most positive deadening effect, when the structure is exposed to vibration or shock. I will refer to this later on in more detail.

The third point is, that in a well balanced design, the governing factor is the elastic limit of the steel. The higher the limit on which you can depend, with the same factor of safety, the more economical the design.

It follows, therefore, that in using mild steel for concrete work, we are sacrificing a great deal of strength, sacrificing a possible saving in material and a consequent economy, all for the purpose of getting a ductile or tough material.

This sacrifice was absolutely necessary in structural steel, but the question I would ask is: Are we not following a false analogy when we make this sacrifice in reinforced concrete? Is there any necessity to sacrifice strength, or conversely sacrifice economy for the sake of great ductility in the rods?

The answer to that question I believe is given in the fact that hard-grade bars soon began to appear on the market, bars in which the carbon was increased to around 40 to 45 points, bars of a higher elastic limit, but still ductile enough to stand the handling and bending. Eleven years ago, in 1911, the American Society for Testing Materials set up a standard specification for billet steel reinforcing bars, divided into three classes, Mild or Structural grade, Intermediate and Hard Grade, in which the Mild grade was given a yield point of 33,000 lb., the Intermediate, 40,000 lb., and the Hard Grade, 50,000 lb. per sq. in.

Rail Steel First Utilized

Some years before this, in fact it is about 20 years ago now, someone, I don't know who, noticed that the physical properties of these hard grade steel bars were practically identical with the physical properties of steel railroad rails, and the thought at once occurred to some steel manufacturers in the States that there was quite a supply available of second-hand rails coming from the big railway systems which could be used as billets from which to roll rods and which could be purchased cheaper than they could themselves manufacture the new billet.

Hence the birth of the rail-steel reinforcing bar industry, which today has reached enormous proportions and is growing rapidly in importance all over this continent. There are in the Dominion and the United States some nineteen large mills engaged in the business, rolling down about one million tons annually of bars, angles, flats, and other small shapes, all from railroad rails, and representing a capital investment of over 20 million dollars.

In 1913, the American Society for Testing Materials recognized the industry by setting up another standard specification for rail-steel bars after an exhaustive investigation had been made.

To sum up these preliminary remarks, we have an industry which has evidently come to stay, and it would appear to be our duty as engineers to investigate thoroughly the question whether or not this industry is based on sound engineering principles. If the answer is in the affirmative, then, inasmuch as the use of this product entails a considerable economy, it would again appear to be our duty to use the material. There undoubtedly is an economy in the purchase price, another economy possible in design, and a third, though indirect economy in the fact that through the existence of this industry, railroad companies are getting much better prices for their second-hand rails than they did when they were sold to be remelted. In other words, there is a national conservation of "work done" in the form of the rail billet. On the other hand, if the answer is in the negative, then it is high time we were rid of an industry and a very healthy industry too, which is putting on the

*From an address before the Toronto Branch, Engineering Institute of Canada, Feb. 16.

market something that is improper from an engineering standpoint. You will see then, gentlemen, that we have a question before us that cannot be lightly thrown to one side, and is certainly worthy of some thought.

I will be quite candid in saying then, that I will try to present to you the affirmative argument, and show that the material is a proper one, and that it is as good if not better than other materials of its class on the market, but let me emphasize the fact that I am wide open to conviction, and would be more than interested to hear the arguments on the other side, and I trust these will be forthcoming in due course.

Origin of Rails Used

Well then, let us start at the beginning, with the raw product. The first question naturally is, when were these rails originally rolled, where were they rolled, and under what specifications. To answer this question I sent out enquiries and personally helped in part to examine some 15,800 rails at various mills in the States and here in Canada. The results I got were these, that the average age of all these rails was 18½ years, that is to say, the average year of rolling was 1903. I found a sprinkling of rails between 35 and 40 years old and one solitary rail which had been rolled in England in 1872, or 49 years ago, another single rail rolled by the Mersey Steel Co. in 1876, or 45 years ago. The period 1900 to 1910 had, however, produced proportionately more rails than any other period. In one mill, I found 106 rails from these limits out of 294 counted, or 36%. In another mill, 75 out of 129 or 58%, in another, 62 out of 204 or 30%, in another 21½%, in still another 53¼%. One mill reported their entire stock as being rolled between these limits, but this was no doubt only a coincidence. The conclusion arrived at was that 1903 was the average rolling year and that 90% of all rail-steel bars on the market today came from rails rolled in the 7 years previous and the 7 years after that date. In Canada 50.5% were rails of English origin and 49.5% American or Canadian. The rails without exception were standard "T" rails, the weights varying from 60 lb. to 100 lb., with a large preponderance of 80-lb. rail.

The next step in our investigation is naturally to find out the conditions maintaining in rail manufacture around the year 1903, and in the seven years previous. Now herein lies one of the weaknesses of this argument, and perhaps the only real weakness from a conservative engineer's standpoint. He does not know definitely under what specifications or under what conditions some of these rails were rolled. We can all look back 18½ years, which is the average age of the rail, that is to 1902 and 1903, and we know that at that time rails were being rolled under a very rigid specification, in fact, practically the same specifications minus a few refinements that prevail to-day. But what we do know about these older rails is that they have stood up just so many years longer to the hard wear and tear of service in the roadbed, that for so many years more they have had locomotives pounding and grinding over them, without showing effects as quickly as the newer rails. This would seem to indicate that if anything they were composed of better material than the more modern rails.

Composition of Old Rails

In looking up the English records, I find that as a matter of fact, analyses of steel rails were not specified until 1890 or 32 years ago. Up to that time the steel manufacturers seem to consider analyses as part of their own stock-in-trade; part of their secret process, only to be given out in confidence. As an instance of this attitude, the head of the inspection company which carried out the inspection of the Forth Bridge in Scotland, informed me that the steel manufacturers would only give out their analysis as a special favor, and that he only saw one analysis on the whole job. This is just over thirty years ago. But when we come down to 18½ years ago, the period in which we are particularly interested, we find quite definite analyses and quite definite specifications.

I have before me a specification of the Illinois Steel Co., dated January 1, 1899, or 23 years old, giving the chemical composition of all their sections from 50 lb. to 100 lb. in weight. The carbon content of the 50-lb. rail was 0.35 to 0.45, the phosphorous not over 0.10, the silicon not over 0.20, and the manganese, 0.70 to 1.00. While in the 100-lb. section, the carbon was higher, namely, 0.45 to 0.55, the phosphorous and the silicon the same, and the manganese from 0.80 to 1.10. On the inspection of the rail the specification reads in part as follows: "The manufacturer shall furnish the inspector, daily, with carbon determinations of each heat and a complete chemical analysis every 24 hours, representing the average of the other elements contained in the steel."

In 1895, which is about as far back as we need go, being eight years prior to the average rolling age, William Hunt, in reporting to the International Railway Congress, gave the following information on New York Central practice.

Five types of rails are used, all of Bessemer acid steel, 65, 70, 75, 80 and 100-lb. per yard; every heat is analyzed for carbon and at least two complete analyses are made each day." The following is the standard specification:

	80 lb. Rail Per cent	100 lb. Rail Per cent
Carbon	.55 to .60	.65 to .75
Silicon	.10 to .15	.10 to .15
Manganese	.80 to 1.00	.80 to 1.00
Sulphur	.069	.069
Phosphorous	.060	.060
Rails are rejected with less carbon than	.55	.65
Rails are rejected with more carbon than	.60	.75
Tensile strength.....	49 tons per square inch	58 tons per square inch
Extension	6 to 12%	

Reporting on English practice on the same date, 1895, Mr. Hunt gives us the following:

"Manchester, Sheffield & Lincolnshire Railway — The steel rails are 86 lb. per yard, and are laid in 30-ft. lengths. The chemical specification prescribes the following:

Carbon to be from	.3 to .45%
Silicon, maximum	.06%
Phosphorous, maximum	.06%
Sulphur, maximum	.06%

In the following test a 5-ft. length is carried on 3 ft. 6-in. bearings, and subjected to three blows from a 10 cwt. weight falling through 10 ft. The rail must not break, nor take a permanent set after the first blow exceeding 1¼ in. Rails are renewed after they are reduced by wear to 72 lb. per yard."

Drop Test

I am particularly interested in this the first mention I can find of the "drop test" on rails, as to my mind this test is one of the most severe imposed on any commercial steel. This note would indicate that the drop test was in vogue in 1895, or 27 years ago, so that the conclusion naturally is that all of the steel rails in which we are interested, except a few old stragglers, have been subjected to the drop test.

In 1906, or 16 years ago, the standard specifications of the American Steel Manufacturers gives the drop test almost word for word with the current specifications of to-day, the trip being 2,000 lb. and the drop for 100-lb. rails being 18 ft.

Before leaving the subject of these older rails, it is quite interesting to look back at the birth and development of the steel rail. Ninety-two years ago Robert L. Stevens, the chief engineer of the Camden and Amboy Railway, was sent over to England to purchase rails, and on the way over he whittled out of a piece of wood a template of the first "tee" rail with a flat base, just as we know it to-day. The first "tee" rail rolled on this side was made by the Montour Rolling Mill, Danville, Pa., in October, 1845. The first

Bessemer steel rail was made in England by Mushet in 1857, so that before we became really interested in the material, a period of about forty years had elapsed, during which time the process was year by year being improved.

In 1885, the American Society of Civil Engineers appointed a standing committee on rails which sat for eight years and in 1893, this committee reported and brought in the standard A.S.C.E. sections which are well known to every railroad engineer. In 1901 the A.S.T.M. published their first rail specification. So, in general we see that the railroad rail has been studied and mothered by the best engineering brains of the country for half a century before we reach the 1903 period in which we are vitally interested.

Careful Purchasing of Rails

The next phase to be considered is naturally the purchasing of the rails. All material entering a rail-steel mill is bought under a strict specification, reading briefly as follows:

"The section must be 50 lb. or heavier, 5 ft. and over in length, free from frog switch, guard curve, bend or twist, and free from split head."

Now there are three safeguards preventing any laxity on this specification. The first is the rigid inspection of the material as it enters the yard, but the second is even more effective, as it is automatic in action. If a rail with, say, a piped head should get as far as the heating furnace, in the first pass through the mill proper, the head will open up and jam in the guides, and the whole process from the handling in the yards to the shipping platform will come to a standstill until the rolls can be cleaned and reset. The operation takes about half an hour, so you can well imagine that the mill-owners are not over-anxious to have this happen too often, and incidentally the bar from the piped rail is never made and never can be made.

The third safeguard against defective material getting into the mill is the fact that if culling has to be resorted to after a shipment is accepted, it means a financial loss to the company, since the defective rails are only good for re-selling as melting scrap at a much lower figure.

Before going more fully into the properties of rail-steel bars, it will be interesting to refresh our memories on the process of manufacturing the rail itself. (Mr. Carswell here exhibited a series of slides showing rail manufacture up to the point of rolling).

May I point out here the similarity of the rail head and the billet. The rail-head is nothing more or less than a billet a little smaller in size, and it is exactly the same process rolling the rail head into a rod, as rolling the billet into a rod. Here we have "rail" steel; here we have "billet" steel, and if the materials are the same then the resultant bars must surely be the same. There is nothing in the nature of re-rolling in this process. It is true there is a long interval between the two sets of rolling, but when the second set starts it is a "continuation" of the process. It is not a case of re-doing anything, it is a case of keeping on doing it.

Faggot Iron

There is a product on the market known in the trade, and properly designated as "re-rolled." The raw material used is little better than junk, wrought iron boiler tube, stay bolts, pipe, and structural shape scrap. This material is cut into small pieces and assembled in bundles. The bundles are placed in a furnace and heated to a fusing temperature, at which temperature the material becomes soft, sticky and pasty, so that the pieces in the pile fuse together. The piles are drawn from the furnace and are worked back and forth through the rolls until the material is welded together and rolled into bars.

New bars of a perfectly good appearance are turned out, but when cut through and etched with acid almost invariably indicate the lack of proper welding, the presence of seams, with slag and other impurities rolled right into the metal. Tests proved it to be anything but uniform in strength or any other qualities and to be laminated in texture.

The term "re-rolled" was used in connection with this material, commonly designated to-day as "faggot iron," and when rail-carbon steel came on the market, the same term was unfortunately applied, and for this reason many engineers to this day seem to be confusing the two products, which as a matter of fact, are really at the two extremes in the steel bar business.

We have discussed up to this point the history of rail-steel, the raw material, the production of the raw material, the age of the raw materials, the prevailing specifications governing the raw material, its purchase and delivery into the rolling mill.

Physical Properties of Rail-Carbon Steel

Coming next to the physical properties of rail-steel, we naturally go at once to the very complete series of tests carried out under the auspices of the American Society for Testing Materials by Prof. W. K. Hatt, of Purdue University.

This investigation was carried on from September, 1912, to February 1913, for the purpose of "obtaining data upon which to base a reasonable specification." No less than 2,036 samples were taken at unexpected intervals from different representative rail-steel mills throughout the country, varying in size from $\frac{1}{4}$ in. to $1\frac{1}{4}$ in. The following are quotations from the condensed report submitted to the A.S.T.M., with comments thereupon:

"(a) This report covers reinforcing bars, re-rolled from steel rails only."

"(b) Chemical analyses were not considered to be essential or helpful and were omitted."

This might on the face of it, seem rather a startling statement, but is it not true that analyses after all are only aids to hasten the acquisition of physical results?

"(c) The lighter sections were originally rolled about 1885 on the average, while the larger sections were of later rolling, about 1900 or thereafter."

Nine years have passed since this report was written so that these dates to-day would be about 1894 and 1909, which bears out pretty well the average rolling date at which I arrive of 1903.

"(d) The writer believes that the diameter of pin specified for the larger bars is not in correct relation to that specified for the smaller bars. If a bar less than $\frac{3}{4}$ in. calls for a pin of diameter three times the thickness of the test bar with a bend of 180 deg. then the larger bars should bend 90 deg. round a pin of diameter six times the thickness of the test bar. The present specifications, provide a pin of diameter four times the thickness of the bar."

Just why Prof. Hatt came to one conclusion and then wrote a specification much more severe than the conclusion warranted, is not quite clear.

On this question of bending it will be granted by every engineer that it is not good practice to introduce sharp hooks or bends into any structure. In my opinion a $\frac{1}{4}$ -in. bar bent round a 3 in. diameter or a 1-in. bar bent round a 6-in. diameter is about the limit of good practice. Hence any rail-steel bars that have passed the A.S.T.M. specification should without any difficulty at all take the bends required for the structure.

Breakage in Bending

Now some of you may say that it is nevertheless a fact that rail-steel bars do break in bending. This is equally true of high-carbon billet bars, but the reason for the breakage is almost invariably the failure of the individual to recognize the fundamental difference between mild steel and hard steel. Hard steel is not as ductile as mild steel, but I do claim that it is as ductile as is necessary for its particular function. The standard specifications take due cognizance of this in prescribing 3 diameters for the bending of mild steel and 4 diameters for hard steel. But in bending in the field, far too often, liberties are taken that should not be taken, and the operation of bending which is really a skilled operation, is left in the hands of a semi-skilled or common laborer. In my own experience, I have

seen many times bars broken, through the operator being too careless or lazy to change the mandril to a larger size when changing to a larger diameter of bar. Crude bending machines which do not allow the metal to flow freely are too often found on construction jobs, and when a husky laborer and a hustling foreman and such a machine get together, the results are bound to be disastrous.

I have on several occasions asked the question whether it is better to have a bar of especially ductile material like mild steel subjected to these sudden unscientific bending stresses and go into the structure with resultant strain at the bend, or to have a less ductile bar which when subjected to sudden jerking stresses will break and cause the bar to be thrown out of the structure.

The bending of rail-steel and hard billet steel should be done by skilled mechanics, and the cheapest and most effective way is to have the work done in the mill, or have the mill send an experienced man to the job, and if ordinary care is taken, there should be no trouble.

Relation of Bar to Rail Properties

Prof. Hatt's next investigation was into the effect on the physical properties of the steel in the rail as compared with the steel in the finished bar. Tests were made on the steel after each succeeding pass through the rolls, and it was found that the tensile strength increased slowly as the bar was reduced to its final size, but that the tensile strength of the mother rail and the finished bar were within 3 to 4% of each other, the rail generally being a little harder. The variability of the product was also examined carefully, in order to get at the number of tons which should be represented by a single sample bar. Samples were taken for this purpose from three of the mills furthest away from each other and the result was that:

"Ninety per cent of the tests lie within a variation of 15% (plus or minus) of the average and the remaining 10% exhibited an increasing variability up to 30%."

There are two more quotations from this report which I should like to give you before leaving it. They are:

"The nature of concrete is to spread loads and average up physical conditions. It would appear that a greater variability of product is, therefore, admissible than in other steel structures, where a structural unit comprehends a few bars."

"Bars in concrete are protected from sharp impacts and sudden loads, and do not need the same toughness as in other structures. Nor are they subjected to the shop processes that demand a tough material. Large concrete bars are, however, usually bent with a maximum bend of 45 deg., small bars to 90 deg., and at times to 180 deg. Here a certain toughness is required, and the bars receive effective field tests when they are bent."

Effect of Shock

While on the question of sudden shocks, there is another interesting bulletin issued by the University of Illinois. It describes a series of tests carried out by Prof. A. N. Talbot, and his associate, H. F. Gonnemann, on the Western Newspaper Union Building, Chicago, an eight-storey reinforced concrete warehouse, just before the building was wrecked to make way for the Union Station. The reinforcing throughout was rail-carbon steel supplied by the Inland Steel Co., of Chicago.

The tests consisted of loading four panels to 913 lb. per square foot. Stresses in the steel bars were registered as high as 57,300 lb. per square inch, and the report states that, "It is apparent that the yield point of the steel was not reached in even the most highly stressed bars." Numerous cracks appeared in the slabs under these abnormal loads, but the report states: "Upon the removal of the load the cracks closed, giving the slab an appearance similar to that which it had before the load was applied."

Steel coupons cut from bars taken from the tested floor, give an average yield point of 63,600 lb., and an ultimate strength of 101,300 lb.

But the point of real interest was the wrecking of the building after the tests had been completed.

"A heavy iron pear-shaped weight (about 1600 lb.) was dropped on the floor immediately over the column capital close to where the column of the storey above had been. After the column capital had been sheared and shattered by this operation, the portion of the floor surrounding the column, and that directly between columns, was broken up with the weight and with sledge hammers. After the concrete sections of the floor had been removed in this way, the reinforcing bars were cut with the oxy-acetylene flames."

Brittleness Argument Unsound

Surely this test alone is sufficient evidence that the "brittleness" argument is absolutely unsound.

I should like to ask two more questions on which I am still seeking information. The first is, has anyone ever seen a rail-steel bar fracture on a bend without breaking in two? The second is, has any one ever seen a rail-steel bar, once embedded in reasonably good concrete, break through shock?

If the answer is in the negative in both cases, as I firmly believe it is, then why worry about this supposed brittleness.

There are thousands of structures of all classes standing up every day to shocks and vibrations, and built exclusively with rail-steel. I have shown some already, and I might mention among others, the Panama Canal, the Ship Lock at New Orleans, in connection with which I have a letter from General Goethals to the effect that he did not hesitate to allow working stresses to reach a maximum of 20,000 to 22,000 lb. per sq. in.; our own new Parliament Buildings in Ottawa, the large terminal elevator at Port Arthur, etc.

In summarizing, I should like to state that the rail-steel bar to my mind is the strongest bar on the market, and hence the most economical. It demands less tonnage, hence less concrete. The metal is subjected to an exceptionally heavy discard in original manufacture and is subjected to a most critical inspection both physically and chemically in original manufacture. Hence the metal is purer and more uniform than usual in commercial steels. The metal has been subjected to the maximum amount of "work" in manufacture, has gone through an annealing process, and is entirely free from internal stresses. The metal is sufficiently ductile to do its work, and the greater strength obtained far outweighs any extra care required in bending and handling.

WILL BUILD BRIDGES AT ILE PERROT

ALL preliminary arrangements for the construction of the two Ile Perrot bridges which will connect St. Anne de Bellevue with Vaudreuil, P.Q., have been completed and work will start in the early summer, according to an announcement made by T. B. McAuley, president of the Ile Perrot Bridge Commission. The Commission, which has been instrumental in interesting both the Federal and Provincial Governments in the importance of the scheme, will continue to function until the bridges are completed. They were now assured of a grant of \$600,000 from the Provincial Government and one of \$150,000 from the Federal Government. In addition to this the Department of Public Works had loaned the Commission the services of V. Denis, one of the engineers of the department, for the purpose of preparing plans for the bridges.

The results of the Ontario Land Surveyors' annual final examinations, held this year at the Parliament Buildings, Toronto, have been announced. Of nineteen candidates who were examined, the following ten were successful: Alfred Cook, Toronto; O. M. Falls, Toronto; G. C. Hagedorn, Kitchener; W. C. Jepson, Niagara Falls; S. L. Lanson, Toronto; C. T. Smith, St. Catharines; D. G. Ure, Sarnia; F. M. Waddle, Brantford; N. E. Ward, Hamilton and D. H. Weir, Winchester. Gilbert Ward, of Toronto, passed the preliminary examination.

THE USE OF CONCRETE PIPE FOR BUILDING STORM AND SANITARY SEWERS

Views of Municipal Officials Who Have Used Concrete Pipe
— Resists Action of Acids and Gases, and is
Impermeable to Water

By M. W. Loving

Secretary, American Concrete Pipe Association

CONCRETE pipe, both plain and reinforced are now being extensively used for building storm and sanitary sewers. It is not definitely known how early concrete pipe were used for this purpose, but records that are available



FIGURE 1—COMPLETED 72-IN. CONCRETE SEWER PIPE IN VERY HARD SOIL

indicate that they have been giving excellent service since 1873 in many parts of the United States and since 1861 in European cities. The following typical statements of municipal officials who have used this material may be cited as an indication of its permanence.

Fred Davenport, consulting engineer, Kokomo, Ind., on March 30, 1921, stated: "The city of Kokomo is now constructing a large relief sewer system of which I have charge of the design and construction and we will shortly remove some concrete pipe that was placed in 1873. This sewer has been in use as a combined storm and sanitary sewer, and from the inspection I have made of it, it seems to be in first class condition. As this pipe has been in service forty-eight years, it is the oldest concrete pipe that I have seen carrying sanitary matter."

J. L. Temple, Commissioner of Public Works, North Adams, Mass., said on November 10, 1921: "You may be pleased to know that cement pipe was manufactured here in North Adams from 1874 to 1879 and there is still in use at the present time 8-in. and 12-in. sanitary or domestic sewers of this very pipe laid at the time it was manufactured. It shows no sign of deterioration and has proved satisfactory."

H. J. Wiegstein, Commissioner of Public Works, Butte, Mont., stated on November 3, 1921: "We use concrete pipe in all sanitary and storm sewers. Don't know of any failure in concrete sewers in Butte. Some have been used for over 30 years. Concrete pipe preferred in Butte."

J. C. Feeley, Commissioner of Public Works, Rutland, Va., said on September 22, 1921: "We have forwarded three lengths of 8-in. pipe (concrete) that has been in continuous use for a sanitary sewer on River Street in this city for 35 years. Despite the fact that it has been on a 3% grade, where the velocity has been high, you will readily see that this pipe is as perfect to-day as the day it was cast and I would not hesitate to relay it on some of our other streets. This pipe is known as the Ripley concrete

pipe and was made to a considerable extent in 1885. While it has not the strength of modern concrete pipe, as it is made today, with good modern practice, we consider it one of the best demonstrations of the ability of concrete pipe that has come to our attention."

R. W. Wadell, city engineer, Kansas City, Mo., on November 2, 1921, said: "Use both cement and clay pipe for storm and sanitary sewers. Tests are same for both. Concrete pipe has given very satisfactory results."

O. P. Mahoney, Commissioner of Streets and Public Improvements, Joplin, Mo., on November 21, 1921, said: "Just completed 19 miles sanitary sewers sizes 8 in. to 30 in. All concrete pipe tested for percolation and crushing strength. Fully satisfied concrete pipe has no superior for sewer work."

Well-Made Pipe Resists Corrosion

Some municipal and consulting engineers are under the impression that harmful acids and gases may exist in sanitary or domestic sewage that will cause disintegration of properly made concrete pipe. While such might possibly be true of poorly made concrete pipe, it is not true of modern pipe made under the standards of the American Society for Testing Materials. Failures have occurred in sewers of concrete which is also true of every other material that has been used for building these structures. Unless proper precautions are taken to fabricate correctly these units, they, like structures of any other material, cannot be expected to give the best results. This is a matter, however, for the engineer to take care of.

Domestic or sanitary sewage usually follows the reaction of the water supply and is slightly alkaline. Occasionally some manufacturing waste may be found which from the nature of the manufacture is slightly acid. Some of the most competent consulting engineers of the country contend that such wastes, when discharged into the laterals



FIGURE 2—TESTING A Y SECTION WITH 160 LB. MAN ON END OF 7 FT. LEVER WITH 5-IN. PULCRUM

or interceptors are generally so small in volume that they are promptly neutralized by the alkalinity of the sewage.

Sewage contains sulphates, nitrates, chlorides and other salts in solution which are not acids. Analyses of sewage in many American and European cities are presented in Metcalf and Eddy's "American Sewage Practice," Vol. 3, and George W. Fuller's "Sewage Disposal." From an examination of these analyses it can readily be seen that practically all of the sewage analyzed gives a slight alkaline reaction.

Studies in connection with the treatment of sewage in Chicago and Baltimore have brought out the fact that the sewage has shown a consistent alkaline reaction for many years. T. C. Schaetzle, principal chemist and bacteriolo-

gist of the Baltimore sewage treatment works, has found that the sewage treated at that plant has shown a slight alkaline reaction for the past seven years. The Baltimore sewerage system is of the separate type so that the sanitary sewage is probably as concentrated as in any American city.

Opinion of Sanitary Engineers

To emphasize the durability of concrete for sewer construction, the following typical statements of two prominent sanitary engineers who have wide experience in sewer design and construction are presented:

Dr. Rudolph Hering, consulting engineer and sanitary expert, of New York, says: "We have plenty of cases in which cement concrete has been used for sewers, extending over a great many years, not to refer to the old concrete sewers of Rome and London, on which I have no detailed and satisfactory information. I know that the large sewers in Paris have been built of rough stone heavily plastered and smoothed with cement so that the sewage flows over the cement surface in the same way as if the entire mass were of concrete. These surfaces at my examination in Paris were quite good. There had been no disintegration. I laid this fact to the density and smoothness of the plaster.



FIGURE 3—LAYING 78-IN. REINFORCED CONCRETE SEWER PIPE.

In 1881, I closely examined the concrete sewers in Vienna, where many had been built both of large and of medium size. The work had been very carefully done and the sewers had been built from 10 years to 20 years. The sewage is rather strong in Vienna, because the water supply per capita is unusually small. I found no disintegration of the concrete surface, which then looked dense and smooth."

T. Chalkley Hatton, chief engineer, Sewerage Commission, Milwaukee, Wis., says: "I have been building concrete sewers since 1893. I have had charge of the operation of these sewers up to 1906, during which time I have had occasion frequently to pass through them for examination and inspection, and have never seen any visible effect upon concrete exposed to sewage or sewage gases which might have resulted from the action of the sewage, and I am of the opinion, broadly speaking, that if the concrete is of the proper character, built and placed in the proper way

—that is, a dense enough mixture and properly mixed—the ordinary sewage or sewage gases generated from an American city will have no effect whatever upon the concrete."

Concrete pipe is highly impermeable to water, thus reducing leakage and infiltration to a minimum. Its permanence and smooth interior are distinct advantages from the standpoint of design and economy. The outstanding features of plain concrete pipe are its great strength, smooth interior, permanence and low percentage of absorption. The concrete used for fabricating such pipe is of a dryer consistency than that used for reinforced concrete pipe, but in this case the concrete approaches the ideal consistency that gives maximum strength. Also, the pipe is produced by machinery in which the concrete is placed under enormous pressure, thus compacting the mass and making possible very low percentage of absorption. Figures 1, 2 and 3 illustrate the use and testing of modern concrete sewer pipe.

ADDRESS ON GOOD ROADS BEFORE OTTAWA BRANCH ENGINEERING INSTITUTE OF CANADA

BEFORE an audience composed largely of engineers and civic representatives, George Hogarth of Toronto, chief engineer of the Department of Public Highways of Ontario delivered a most interesting address on "Our Public Highways" at Ottawa on February 16. The lecture which was given under the auspices of the Ottawa branch of the Engineering Institute of Canada, was illustrated by some 150 lantern slides as well as two motion picture films. Mr. Hogarth, who was introduced by K. M. Cameron, the chairman of the Ottawa branch of the Institute, dwelt on the course of road-building in Ontario, from the revival of five years ago, to the present time. Mr. Hogarth then proceeded to discuss the need for improved roads in Ontario and how this improvement was brought about.

The lecturer pointed out that the development of the motor car created the necessity for good roads, and these developed with the development of motor vehicles. He outlined the various types of roads in Ontario. There was first the township road, which was of various types. Some of these township roads had been taken over by the county as county roads. Some near cities had been taken over by suburban road commissions. On such as were still township roads the government paid 20 per cent. towards the cost. The roads were usually of earth and gravel and were frequently narrow, as they did not represent main travelled thoroughfares. Of the total township roads of a few years ago the Ontario counties had now assumed about 15 per cent. as county roads. On these latter the government paid 40 per cent. of the rebuilding and maintenance. Then there was the still higher type of county provincial roads which were constructed of all materials so far from earth and gravel to concrete. On these the province paid 60 per cent.

In 1918 the Ontario government took over the Ottawa-Prescott road. At that time it was a narrow and winding trail. Now in three years it had been graded, surfaced, and one day last fall, on an inspection trip, the inspecting party went over the 58 miles from Ottawa to Prescott in 2 hours.

The Ottawa-Prescott road had been built, but had not yet been paved or permanently surfaced. There were heavy grades on it and in some cases these had sunk anywhere from six inches to several feet. These places will be filled up this summer, but the road will take another year to settle to its permanent place. Then it will be surfaced where necessity demands.

The Ottawa-Point Fortune road had now been paved for 21 miles and another year would see all the culverts, etc., in good shape. The Ottawa-Kingston road had progressed some, but there were stretches of this road which were not very largely travelled and it would be some time yet before all the culverts were phased. Progress was being made on the Ottawa-Pembroke road, culverts were being constructed and a base course has been put on Carling avenue.

HYDRAULIC EQUIPMENT AS AFFECTING POWER HOUSE DESIGN*

Marked Increase in Turbine Efficiencies — Present Tendency is to Increased Speeds — Features Affecting Installation of Main Units and Auxiliary Equipment

By Max V. Sauer

Hydraulic Engineer, Ontario Hydro-Electric Power Com.

THE modern hydraulic turbine has been developed to its present state through an interesting cycle. The earliest type consisted of a single runner, mounted on a vertical shaft and was usually set in an open flume, with no provision made for directing the water to the runner or for discharging it away from the runner. With the application of turbines to driving electric generators, the necessity at once arose for larger capacities and higher speeds, not to mention the requirements of regulation. This resulted in the development of the multiple runner type, sometimes on a vertical shaft but more usually on a horizontal shaft. Installations are known where as many as eight runners were mounted on one shaft. As speed regulation became more important the multiple runner type presented serious complications due to the fact that regulating gates for all the runners had to be connected together and the system became very cumbersome and complicated. Even with this type not much attention was paid to a proper distribution of the water to and from the turbine, and while there were several installations with efficiencies in the neighborhood of 80%, this was the exception rather than the rule. The necessity of obtaining larger capacities while, at the same time maintaining the turbines free from complications has led through various steps to the present type of high capacity high speed turbine consisting of a single runner mounted on a vertical shaft with the water led to the runner through a spiral case and away from the runner through a well designed draft tube.

The final development was delayed for some time on account of the difficulty of providing a dependable vertical thrust bearing. While the oil pressure type was fairly satisfactory the system was complicated and subject to frequent failures. These difficulties are now overcome and at least three satisfactory types are on the market.

Remarkable Increase in Efficiencies

Since the year 1900 the efficiencies of turbines in general have been advanced to a remarkable degree. Twenty years ago 80% maximum efficiency was considered to be the last word in turbine installation while today there are several plants in which the turbines are operating at from 90 to 93% efficiency.

This great advance in efficiency is not due alone to improvement in runner design, but can be accounted for in great part by the more careful proportioning of the spiral casing, the reduction of clearances between the runner and the casing, and the improvements in the design of the draft tube discharging water from the runner to the tail race. The flow of water from the entrance of the scroll case to the discharge at the tailrace is now accomplished without any abrupt changes, resulting in freedom from eddies and consequent loss of power.

With the present high efficiencies attained it can be readily seen that further increases will not be forthcoming except by very small increments. The present tendency is to develop a runner of higher specific speed without at the same time a sacrifice of efficiency. That progress has been made along this line is shown by the fact that the specific speed of the turbines in one of the Niagara Falls plants erected ten years ago is 20 while that of the new Queenston-Chippawa Development operating under a higher head is 34. The demand for higher speeds on large

capacity low head turbines has been brought about by the great saving in cost in the generators, and the turbine manufacturers have now developed a still higher speed type of runner to meet these conditions.

Application to Power House Installation

Where the type of turbine for any given development has been fixed the next consideration in power house design is the number of units to be installed. As a general rule they should be made as large as possible so that their number may be kept to a minimum on account of simplification of operation and lower initial cost.

There are always other features however which may modify this general consideration. For example, in an isolated plant (i.e. one not connected with other plants) the number of units should be not less than three, and in many cases four, so that sufficient flexibility of operation may be obtained and also because a failure in any one machine will not tie up too great a proportion of the plant.

Another feature that usually affects the number of units is the fact that only a portion of the plant is installed initially, on account of the load requirements being smaller than the ultimate capacity.

In a large installation where the above considerations do not apply to any great extent the following example indicates the method of procedure in the determination of the size and speed of the individual units.

Assume a development of 60,000 h.p. at 50 ft. head. First assume an installation of five units of 12,000 h.p. each. An examination of performances of modern turbines shows a generally average ratio existing between specific speed and head, as follows:

Head	Specific Speed
20	100
50	75
100	52
200	39
300	33
500	27
600	24

The fundamental expression for specific speed is $K = \text{R.P.M.} (\text{H.P.})^{1/3} / H^{3/4}$, where K is the specific speed, R.P.M. the revolutions per minute of the turbine, H.P. the horsepower developed, and H the operating head.

From the above tabulation it will be noted that a specific speed in the neighborhood of 75 is correct for the unit under consideration.

Hence, $\text{R.P.M.} = 75 (50)^{3/4} / (12,000)^{1/3} = 91$.

If the frequency of the plant is 60 cycles per second the nearest synchronous speed to this is 90 r.p.m. which would satisfactorily meet the conditions. It would require an 80 pole generator, however, and it would probably work out more economical to reduce the units to 10,000 h.p. each. This would require six machines operating at 100 r.p.m.

For high heads with relatively small output this analysis will indicate speeds in excess of the best practice. For example it would show a speed of 820 r.p.m. for a 6,000 h.p. unit under 600 ft. head. Such a speed is almost sure to give trouble after a short period of operation as the slightest unbalance will set up dangerous vibrations which become aggravated as time goes on with the result that the units require frequent overhauling with consequent loss of time in service. Generally it is not advisable to operate turbines of capacities in excess of 1,000 h.p. at a higher speed than 500 r.p.m.

Auxiliary Equipment

The auxiliary equipment in any plant plays a most important part in its output from the point of view of regulation and of that ideal of all operators — continuity of service. It must be installed with two vital objects in mind: ease and convenience of operation, and absolute dependability under all emergencies. This latter condition can be attained in many cases only by duplication of the apparatus.

*Paper read at Water Power Symposium, University of Toronto, Feb. 28, 1922.

Under the classification of hydraulic auxiliary apparatus is included:

1. Service units.
2. Governor pressure system;
3. Penstock valves.
4. Lubricating system.
5. Service water supply.
6. Drainage.

The governors are not included as they are essentially part of the turbines.

The service units must be in duplicate since they are the source of power for the plant equipment such as emergency excitation for the main units, the governor pressure pumps, the lighting system, flood drainage pumps, travelling cranes and repair shop machinery.

A major interruption may shut down the whole plant and in order to get back on the load without delay, service from the governors and exciters must be immediately available. For this reason one service unit at least should be independently turbine driven. The layout requires as much care and attention as that of the main units and it is an unfortunate fact that auxiliary equipment is frequently installed in a manner which indicates a lack of appreciation of its vital function. The unit should be completely independent in that its own governor pressure system should be separate from the main system with provision for interconnecting with it.

For supplying pressure fluid for governor operation two systems are available and as both give satisfactory results it is a difficult problem to determine which to install in any given development. The first, or multiple unit system, consists in having a separate pump and sump tank for each unit, and the second, or central system, in having the units connected through headers to a central pump.

For security of operation the multiple system is tied together with a header on the pressure side provided with sectionalizing valves so that in the event of failure of any pump, the governor for the unit can be connected to the header and supplied by the other pumps in the system. To provide against failure in the central system a duplicate pump is installed which can be thrown into service should the first pump fail. A duplicate system of headers is also frequently advisable.

Multiple Unit System

The advantages of the multiple unit system are, first, its greater flexibility, and its simple application to an initial partial plant installation. As the plant grows individual pump units can be added as the turbines are installed, and in this way the system is always complete in itself. Another advantage is that the failure of one pump unit does not in any way cripple the service, since with all the units being tied together the remaining pumps in the system will easily take care of the disabled unit. The main disadvantage of a multiple unit system is found in the fact that a great proportion of the operating attention is required for the maintenance in service of a number of small units. Multiplicity of pumps means more failures of small parts with a consequent danger of an insignificant failure being responsible for the shut-down of a main power unit.

Central Pumping Station

The advantage of a central pumping system lies in the simplicity of the lay-out, with few parts to give trouble and with concentrated operating attention. Furthermore, since the operating fluid for the whole plant is handled by one pump, this pump is necessarily of large capacity, resulting in a rational design and one of much better operating characteristics. The pump in the central system is therefore usually of the multiple stage, centrifugal type, which is ideal for the varying load conditions imposed by governor service. In the multiple unit system the pump capacities are not large enough to permit satisfactory centrifugal designs, with the result that they are usually of the gear or plunger type, and consequently noisy in operation.

The main disadvantage of a central system lies in the fact that for partial plant installation the layout is unbalanced and of too great capacity for the few number of units initially installed. If the pump is automatic, electrically controlled the small output demanded results in frequent starting and stopping with consequent wear and tear on the motor; or if operated continuously through pressure regulating devices the governor fluid becomes very hot.

With the use of centrifugal pumps it has been found that oil as a pressure medium is not satisfactory, owing to the emulsification due to the churning action of the pump. For this reason water treated with one or two percent of a soluble oil or a small amount of bichromate of potassium is now used and is found to operate successfully. Water thus treated acts efficiently as a lubricant in the working parts of the governor and has no tendency to produce rust.

There is a tendency in the present pressure systems to design the operating cylinders on the turbines to work at lower pressure than formerly; where in the older plants this pressure was from 200 to 250 lbs. it now ranges in the modern developments from 135 to 200 lbs. This results in much less trouble from wearing of the valve seats and leakage in pipe connections.

In the older type smaller capacity turbines the emergency control in the event of governor failure could always be had by throwing the turbine gate mechanism directly over onto hand control. As the capacities increased this direct hand control became too cumbersome and difficult to operate owing to the large masses in the gate mechanism which had to be moved. Hand control was then obtained by simply switching over from governor control to hand control of the pressure operating the governor cylinders. Such an arrangement however still left the control of the unit dependent on the maintenance of the governor pressure system, and if this failed control of the unit was practically impossible. In plants where the head is 200 feet or more it is therefore advisable to connect the governor pressure system direct to the penstocks, thus permitting penstock pressure to operate the governor in extreme emergency. Where the head is lower than 200 feet and in consequence not sufficient to operate the regulating cylinders the only recourse left is to install hand pumps directly on the regulating cylinders. With such an arrangement the machine can be shut down, but it necessarily takes a considerable length of time.

HAMILTON ENGINEERS HEAR ADDRESS ON STANDARDIZATION

AT A meeting of the Hamilton branch of the Engineering Institute of Canada held at the Royal Connaught Hotel, an address on "Standardization" was delivered by R. J. Durlay, secretary of the Canadian Engineering Standards Association. There was a good attendance of members of the Institute, as well as purchasing agents and other employees of local manufacturers. The address was largely technical, but was made interesting as well as instructive by the introduction of the personal element and illustrations of what had been accomplished by research work during the great war, particularly by the aircraft board of Great Britain. Greater advancement has been made, he said, in Europe, in the standardization in machinery work than in America, the Swiss and Germans leading in the movement for interchangeable parts and in the simplifying of the work of tool cutting and making. In America the automobile engineers have done much in the matter of standardizing in the steel industry.

A project to develop one million horsepower from the Lachine Rapids has been abandoned indefinitely owing to the insolvency of the Lachine Rapids Power Co., sponsor of the scheme. It was proposed to build a dam across the St. Lawrence from a point 300 ft. east of the present plant of the Montreal Light, Heat & Power Co. to Heron Island and thence to a point immediately opposite.

ROAD-BUILDING IN ONTARIO*

Some Notes by a Well-Known Visitor from the United States — Comparisons with Mileage and Practice in That Country

By Prevost Hubbard

Chemical Engineer, The Asphalt Association

ALTHOUGH I have not had a chance to study the development and present status of highway work in Ontario, from what I have heard and understand to be the present situation, I believe the province is to be congratulated on what has already been accomplished and upon the future possibilities which are directly dependent upon the work it has already done.

The Deputy Minister of Highways informs me that there are in Ontario to-day some 27,000 miles of hard-surfaced roads, which is nearly 10% of the present total mileage of such roads in the United States. According to the latest data that we have been able to secure, we have estimated that on January 1, 1920, there were in the United States, outside of municipalities, about 256,000 miles of roads of a higher type than earth or sand-clay, and the mileage to-day is probably not much greater than 275,000. The area of Ontario is about 11% that of the entire United States, and its population less than 3%. It, therefore, appears that Ontario has almost as much mileage of hard-surfaced roads, per unit area, as the United States, and per unit of population about three times as much.

In the adoption of improved types of highways higher than gravel and macadam, I believe, we in the United States are still in the lead, as we estimate that about one-fifth of our hard-surfaced country roads are of these higher types, while the same is true of considerably less than three per cent of the roads in Ontario. While gravel and macadam roads are not as permanent in character as the higher and, for first cost, more expensive types of highways, they are undoubtedly the most economical to adopt up to a certain traffic limit. They, therefore, constitute an extremely valuable asset to the community which they serve, and represent an investment well worth conserving. Such a policy of conservation has I understand been adopted by the present Provincial Highway Department. When developing a system of heavier traffic highways, in many cases it becomes possible to utilize the existing gravel or macadam roads, so as to make their replacement value practically a permanent investment.

City Paving Practice Should Not Be Overlooked

It may be of interest to review a few facts in connection with the development of the heavier traffic highway systems in the States, and in this connection the experience and practice of our cities should not be overlooked. To me it is an almost incomprehensible fact that in building our state and county highway systems more weight has not been attached to paving practice in our cities where many of the problems of meeting heavy and varied traffic conditions were successfully solved before such conditions made their appearance on country and suburban highways. In our cities the original waterbound macadam and gravel roads have for the most part given way to higher types of construction until to-day they constitute an average of only about 26% of the total yardage. The three most widely used city types are asphalt, brick and stone block. If we eliminate the waterbound pavements we find that of the higher city types asphalt constitutes about 55 per cent, brick about 19 per cent and stone block about 14 per cent, giving a total of 88 per cent of these three types.

In connection with the preponderance of asphalt pavements, the present trend of paving practice in the constructive modern brick and stone block pavements is of considerable significance, as it recognizes a principle which just now

is attracting a great deal of attention on the part of our highway engineers. I refer to the use of a flexible joint filler for brick and block pavements as against the rigid grout fillers formerly so popular. Such cities as New York and Philadelphia are now using asphalt fillers for heavy traffic streets paved with stone block, and both the Paving Brick Manufacturers' Association and the Association of Stone Block Manufacturers are preferentially recommending asphalt as a filler for their respective types of pavements. The reason for this lies in the fact that absolute rigidity in a pavement structure is not a desirable characteristic. Service results and comprehensive field tests conducted by the U. S. Bureau of Public Roads have demonstrated that the brick or block pavement with a flexible filler is more resistant to traffic than with a rigid filler. A certain degree of flexibility is highly advantageous in meeting the heavy impact of modern traffic. Such flexibility is an inherent characteristic of bituminous pavements and is imparted to brick and block pavements when asphalt is used as a joint filler.

Flexible and Semi-Flexible Types of Construction Predominate

While in certain sections of the country the experience of our cities appears to have been overlooked, it is a fact that the flexible or semi-flexible types of construction predominate in our country roads and if we consider the total mileage of state, county and municipal highways higher than gravel and macadam, considerably more than 50 per cent may be classed. By reducing all yardage to a basis of 16-ft. width, we estimate that at least 45 per cent of the mileage of the higher types of pavements are of the hot-mix asphalt types. Our latest available information indicates that last year the total area of asphalt pavements constructed approximated 68,000,000 sq. yds., which was greater than for any other type. Most of the stone block pavements constructed that year were filled with bituminous material and we are informed that about 60 per cent of the brick pavements were similarly filled.

There are, it is true many advocates of the all rigid monolithic types of construction and in certain sections such pavements predominated in last year's work. This is not true, however, of the country as a whole. Those who favor rigid construction have constantly been obliged to increase the massiveness of design of such pavements, and also the amount of reinforcement, in an endeavor to successfully meet the destructive action of heavy traffic, while those who favored the semi-flexible or flexible types have in general found that the old standards of design have proven satisfactory. The all-flexible types, such as the black-base pavements so extensively adopted in our far-western states, appear to be the most highly resistant per inch of total thickness, and may therefore be considered the least massive, and in this respect the most efficient, of the heavy traffic pavements.

It is probable that such pavements will be given considerable attention in the 1922 program of some of our eastern states owing to the remarkably satisfactory results obtained over a long period of years in the west. Many of these pavements are 6 in. or less in total thickness.

What we have learned in the past few years about the destructive affect of traffic impact and the resistance to impact offered by semi-flexible and flexible highway structures has a peculiar significance in connection with a great economic problem that of conserving our investment in old roads, particularly gravel and macadam, when it becomes necessary to adopt a higher type of wearing surface. Prior to the careful investigation of this important subject there existed a marked and growing tendency to discredit the use of old gravel and macadam roads for foundations for the higher types, and this in spite of many remarkable service records of macadam foundations.

For example, in the city of New York a number of the most heavily traveled streets were constructed years ago on macadam foundations and some are still giving satisfactory service. In 1890 Broadway between 59th and 79th streets was paved with asphalt over an old macadam base

*Address delivered March 1, 1922, before the Ontario Good Roads Association, Toronto, Ont.

and for 22 years gave good service. Its replacement at the end of this period was largely due to subway excavations. Paved in a similar manner, 72nd St. gave 22 years of service under increasingly severe traffic conditions, and the same is true for a 19-year period for Fifth Ave. between 110th and 120th streets. Lennox Ave. between 110th and 124th streets was surfaced with asphalt over old macadam in 1904 and is still giving good service. The cost of maintaining this section in 1919, or 14 years after construction, was only 1% — certainly a remarkable record. I have mentioned these few examples, only for the purpose of illustrating the point. Many similar cases might be cited from various localities.

A recent investigation of rolled stone bases for brick pavements was conducted by the U. S. Bureau of Public Roads, and A. T. Goldbeck, of that Bureau, has published a very favorable report on this type of brick construction. All in all it appears that the old waterbound base is again coming into its own.

Methods of Sub-Grade Preparation Improving

One reason for much of this former dissatisfaction with such bases was undoubtedly due to a fault which has been all too prevalent in the rapid development of our country highway systems. I refer to inadequate preparation and drainage of our sub-grades, fostered by the false idea that the cost of such work would make the total cost prohibitive. Political pressure and popular demand for the rapid construction and greatest possible mileage of improved roads for a given amount of money, was to a great extent responsible for this state of affairs. I am pleased to say, however, that this subject is receiving an increasing amount of attention and is being most carefully investigated by the U. S. Government and a number of public service bodies and technical societies, the work of the various organizations being correlated by the Advisory Board on Highway Research of the National Research Council. I believe that most of our highway engineers are now fully alive to the importance of this subject and that marked improvement in our present practice of sub-grade preparation and drainage will shortly follow.

Others frequently see our faults before we, ourselves, fully realize them. W. A. McLean tells me that for a long time he has believed that the failure or unsatisfactory condition of many of our highways is due to their having been constructed in one operation, and that much of our sub-grade troubles can be attributed to this fact. I think I can fully agree with him in this matter, particularly in view of our lack of information on sub-grade conditions prior to construction. Without such information rapid development of a higher-type highway system is almost sure to result in many costly failures.

I understand that the present policy of the Ontario Highway Department is, where new construction is contemplated, to grade the roads a year in advance of surfacing; then where traffic conditions do not immediately demand a higher type, to surface these roads with gravel and macadam, with the ultimate idea of utilizing such roads as foundations for more resistant wearing courses when they become necessary. I believe this policy to be thoroughly sound as it gives opportunity for hunting out and correcting all existing sub-grade troubles before the more expensive surfacing is laid. Such a policy may, and I understand has, caused some dissatisfaction on the part of those who are over-anxious to see and travel over the completed highways at the earliest possible moment, but I believe the great mass of the people may be educated to appreciate the fact that this policy ultimately means more and better highways for a given amount of money.

Thickness of Old Roads Often Overestimated

From what I have gathered during my short visit, it appears that ultimately a considerable portion of the higher-type roads in Ontario will have a macadam or gravel base, and in conclusion, I wish to call attention to just one other matter which has been a very common fault in our work and has often resulted disastrously. This is

the over-estimation of thickness of the old road when it has been decided to utilize it for a foundation. All too frequently we have laid an expensive pavement on an old road actually three inches or less in thickness, when it has been estimated as not less than 6 or 8 inches thick. Macadam and gravel roads wear away very rapidly in comparison with other types, and because records show that a large tonnage of road metal has been used in the construction and maintenance of the old road, it does not by any means follow that most of such material is still on the road. It is very essential, therefore, to determine accurately the existing thickness of the old road before utilizing it as a foundation.

I believe that wherever possible the old road should be left undisturbed rather than to scarify and reshape it, which destroys much of the stability that compression under traffic has brought about. It is quite necessary that the old surface be trued up before the wearing course is laid; but if the reconstruction is to be completed in one operation, the placing of the bituminous mixture in existing depressions will usually prove to be the best practice. If the existing road is not sufficiently thick to serve as a foundation, it may conveniently be reinforced with a thin course of black-base mixture before the wearing course is laid.

ZONING OF BUILDINGS UNDER TOWN PLANNING

ZONING of buildings in cities was the subject of an address by W. E. Hobbs, Manitoba provincial town-planning controller, to the members of the Manitoba Association of Architects at Winnipeg. "Zoning," said Mr. Hobbs, "is the creation of 'use districts.' Under present conditions, there is nothing to prevent the intrusion of an apartment block or a store into a residential district. Similarly, there is nothing to prevent a factory or other undesirable use of land from intruding itself into a shop and office area. Industries of an objectionable nature may go anywhere so long as the land can be purchased. This results in depreciation of property values in the vicinity of the intrusive occupation, and, in some instances, where undesirable occupation becomes marked, the occupiers of property leave the district, and in some cases, property values drop so that there is not only a personal loss to the owners of the land affected but, by the reduction of values, the assessment also drops, and therefore a smaller amount in taxes is collected.

"To prevent this, and to stabilize conditions, zoning has been resorted to by many cities on this continent, and also in Europe. There are three factors in a zoning or distributing scheme. First is the defining of the boundaries of 'height areas.' In those areas the maximum height to which buildings may be erected is fixed, usually in terms of the width of the street upon which such buildings face. In New York, these areas are classed as 2½, 1½, 1¼, etc.; the numbers refer to a multiple of the width of the street with 100 ft. as a maximum and 50 ft. as a minimum.

"Then there is the defining of the areas in which the percentage of the lot upon which the buildings may be constructed is prescribed. These percentages usually vary from about 100 per cent. to a minimum of 30 per cent., the larger percentages being applied in business areas and the smaller in residential areas.

As fixing the height and area of a lot which may be occupied by a building does not prevent any occupation of a building objectionable to other occupants in the vicinity, it is also necessary to prepare a third map which defines the boundaries of areas of the properties within which have a uniform base. Thus residential, commercial, industrial and other buildings are kept within their own boundaries and cannot encroach upon each other. The boundaries of the areas for height built upon area and use do not necessarily coincide with one another.

"Winnipeg is very much in need of a zoning scheme, particularly if industries are to be attracted to the city, and it should be in the interests of the citizens as a whole to institute such a scheme."

CONCRETE BRIDGES AND CULVERTS*

Formulae Used to Determine Size of Structure — Type of Construction to Suit Conditions — Loading Considerations — Peculiar Features of Different Foundations

By W. J. Moore

Highway Engineer, County of Pembroke, Ont.

BRIDGES and culverts are necessary in the construction of highways in order to permit the safe passage of traffic over streams and ravines, and the flow of streams under the highways. In this latter connection there may have to be taken into consideration the designing of a waterway suitable for navigation or for the driving of logs in lumbering operations, as well as one suitable for the maximum flow of water which may occur.

Examination of Site

The first essential towards the construction of a new bridge or culvert is a proper examination of the site. A survey should be made taking in a strip fifty or more feet on each side of the centre line of the highway and for as great a distance along it as can possibly be affected by the construction of the approaches. Levels and measurements should be taken along this strip sufficient to make an accurate contour plan. If there is an old structure there, it should be measured up and enquiries made as to whether it has been of sufficient capacity to accommodate the stream at flood-times. High and low water marks should have their elevations determined and a cross-section of the stream bed should be taken along the centre of the highway. Soundings and borings should also be taken to determine the character of the foundation. This is a very important part of the work and is too often neglected, the consequences being frequently disastrous.

Area of Waterway

In the design of culverts a contour plan should be made of the strip of land previously surveyed and also a profile of the centre line of the highway for some distance on each side of the site. On these should be marked most of the information acquired during the survey. The next step is the determination of the area of the waterway. This may be done in one of three ways, viz., theoretically, empirically or by observation, and in so doing there are several factors which should be taken into consideration.

In the first place, the size of the opening will depend on the amount of rainfall, which amount will be the maximum amount of rainfall for the time required by the run-off to reach the culvert from the most distant part of the watershed. For example, if it is found that it required 30 minutes for the rainfall from the farthest point of a drainage area to reach the culvert, then the area of the waterway should be designed for the maximum rainfall for 30 minutes as observed for the district in question. The figures for maximum rainfall for various districts may be obtained from the Meteorological Service of the federal government. I have been the observer at Pembroke for about ten years, and the maximum storm during that time has been a rainfall of 1.90 in. per hour for a period of 35 minutes.

Not all of the rainfall on an area reaches the outlet, and the portion which does is known as the run-off. The amount of run-off is affected in various ways. The watershed may be long and narrow and covered with dense vegetation, and hence the flow of water may be retarded; or the soil may be of a sandy and porous nature and hence absorb more of the rainfall than if it were clay. Then again, in a northern country, it is possible to have a rainfall on snow accompanied by a thaw and the conditions in addition to the fact that the ground is frozen and practically impervious may give rise to a maximum rate of run-off.

In a theoretical determination of the area of a waterway, many assumptions would have to be made regarding the points mentioned above and the area arrived at by the use of the formulae for the flow of water in open channels. This is a laborious method however, and owing to the many doubtful factors is hardly worth the trouble involved.

Empirical Methods

There are then the empirical methods by which certain formulae are used which have been devised from experience. Chief among the formulae are Myer's and Talbot's. These are as follows:

Myer's, $A = C$ (Drainage area in acres)^{1/2}

Talbot's, $A = (\text{Drainage area in acres})^2$

where A is the area of the waterway in square feet and C is a coefficient varying with the character of the watershed.

Probably the best method, however, is by observation of the flow through existing structures and by enquiry from persons residing near the culvert. In railway practice before the days of the N.T.R. on which permanent structures were built at once, it was the custom to build temporary wooden culverts of ample dimensions. Each year the high water mark was observed and painted on the walls. In this way, after a lapse of eight or ten years when the life of the temporary structure had expired there was reliable data as to the size required for the new permanent culvert. Highway engineers are mostly concerned with roads which have been in existence for years and culvert or bridge work generally consists of replacements of existing works, consequently much information may be acquired by observation and enquiry. Should the culvert be situated on a new location there will, no doubt, be other structures on the same stream either above or below the proposed work, observation of which will give all the data required.

Culverts

The particular type of structure for a given location, is called a bridge or a culvert, arbitrarily in accordance as to whether the span is over or under fifteen feet in width. If a culvert is required, it may be either a plain or reinforced concrete arch or a box culvert. Arches are chosen where the head room is sufficient for this type and where it is thought that a more pleasing effect may be obtained by their use. Box culverts are, however, used more generally due to their suitability for sites where headroom is restricted and to the fact that the form-work on them is not so complicated, as well as for the reason that the load is more evenly distributed on the foundations and less care need be exercised on this account.

Box culverts may be either open or closed boxes. In the former there is not a concrete floor and the load is carried on footings beneath the side walls, while in the latter there is a reinforced concrete bottom which is designed to carry the load.

The length of culvert depends on the depth of the fill on top of it. Assuming the slope of the fill to be $1\frac{1}{2} : 1$, then the length of the culvert will be the width of the roadway plus three times the depth of the fill over the top of the culvert.

Loadings

Loading on culverts is generally considered to be the total weight of the fill above it for the full width of the excavated trench. No allowance is made in fills less than 30 ft. deep for the arching of material above the culverts. In addition to this is the weight of the culvert itself which is generally figured as equal to a like volume of the superimposed earth.

Lateral pressure on the sides of the culvert is generally assumed as one-fourth of the pressure on top. The live load surcharge is added to the top soil pressure in designing top and bottom slabs. The top and bottom slabs are designed as simple beams supported at the ends but not fixed. Reinforcement in them is generally about 1% of the total section. The transverse reinforcement is the most important, but longitudinal reinforcement is also used, as due to un-

*From a paper presented at the Eighth Annual Conference on Road Construction for County Road Superintendents and Engineers, Toronto, Feb. 27.

equal settlement, the culvert as a whole may be subjected to beam stresses. The side walls are frequently not reinforced but are made of ample dimensions to resist the lateral pressure.

The bottom slab is generally of the same thickness and reinforcement as the top but in this the reinforcement is placed near the top whereas in the top slab the reinforcement is placed near the bottom.

End walls on culverts may be of three or more kinds. Some are built as continuations of the side walls with a slope equal to the slope of the bank, some are built at right angles to the barrel of the culvert, while others are built at an angle of 30 or 45 deg. with the side walls. The choice will be controlled by the desirability of providing a clear flow. They should be designed of sufficient weight to resist the overturning effect of the bank behind them and to resist the impact of all kinds of vehicles.

Concrete Bridges

In recent years, more and more reinforced concrete bridges are being built. The following are the kinds usually recommended for various conditions:

- (1) A concrete arch or concrete abutments with reinforced concrete slab top for spans up to 20 ft.
- (2) A concrete arch or a concrete beam bridge for spans from 20 to 40 ft.
- (3) Concrete arch for spans exceeding 40 ft.

Concrete truss bridges have also been used somewhat in recent years.

Arch bridges may be divided into open spandrel and closed spandrel bridges. In open spandrel bridges the load is carried on a system of beams and columns which rest on the arch, while in closed spandrel bridges the spandrel walls are built solid as retaining walls to confine the filling over the arch. Arch bridges are also classified according to the form of the arch as circular, multi-centered, elliptical or parabolic.

In a paper such as this it would be impossible to go thoroughly into the design of the different kinds of concrete bridges. It is sufficient to say that they should be designed by competent men and carefully supervised in construction. A point that should be emphasized, however, is that it is especially essential to have a stable foundation. Of all the failures of bridges that are recorded, by far the greatest cause is the neglect of attention to this rule.

Foundations

Foundations for bridges are either natural or artificial. Natural foundations are (a) Rock, (b) Gravel, (c) Sand, (d) Clay. The allowable pressure per square foot to which the different classes may be safely subjected may be found in any good handbook.

Rock is generally a satisfactory foundation, but sometimes owing to the formation it is inadvisable to build upon it until it is levelled off or cut into steps.

Gravel is a good foundation, but it is necessary to be sure that the stratum is sufficiently thick. Gravel may also be washed out from around a pier causing its failure. In the county of Renfrew this happened in two instances during the past summer to bridges on the Madawaska River. At Stewartville, a central pier was undermined by the action of the swift current, turned partly over and distorted the trusses on the adjoining spans. At Griffith also a similar thing happened. It is necessary therefore in locations such as this to carry the pier down a sufficient depth and if necessary to protect it by a rip rap, a concrete apron or otherwise.

Sand varies from the coarse variety to quicksand, which is probably the most annoying material to work with that exists. Piling is generally resorted to where this occurs, sheet piling being frequently used.

Clay also varies from the firm variety almost approaching shale in its characteristics to a wet soupy material as unstable as quicksand. Sometimes in clay the strata are inclined steeply and a subsidence takes place which spells disaster. This occurred a few years ago at a bridge over

the Madawaska River in the Township of McNab and known as the clay-bank bridge. A shore pier carrying the ends of two girder spans was overturned by a slide of the foundation material.

Artificial foundations may be either of piles, grillage or cribwork. Of these the use of piles is the most universal and satisfactory. Piles may be of almost any variety of sound timber and should be straight. The bearing power of piles depends on the friction of the timber with the earth throughout its whole length and not on the bearing on the point alone as is sometimes popularly supposed. The bearing power is reliably determined by the Engineering News formula.

It must be remembered that on piers and abutments the pressure is not always uniform over the entire area. In abutments the pressure will be greater on the bridge side than on the approach side owing to the overturning effect of the earth fill; and in piers the spans may be of unequal length and thus cause more pressure on one side than on the other. Piles should therefore be spaced closer where the pressure is greatest.

Specifications and Construction

Of equal importance with the proper examination of the site and a fitting design is the further elaboration of the project by complete specifications, a careful detailed estimate and finally the faithful following of plans and specifications in the actual construction.

Specifications, without being too verbose, should cover every particular item of the work both generally and as to materials and methods.

As to the actual construction, the best method will depend on the particular work to be done and the conditions surrounding it. Attention should be paid to the qualities of the various component parts of the concrete. Except for large undertakings cement is not usually tested but is accepted as it comes from the factory. As a rule no serious results occur from this practice.

Aggregates, which constitute about 90% of the concrete, are classified as coarse aggregates and fine aggregates. Coarse aggregates are all particles of gravel, crushed stone, or other materials above $\frac{1}{4}$ in. in diameter. Fine aggregates are all particles below $\frac{1}{4}$ in. in size. As the chemical and physical proportions of the aggregates are not changed by mixing with cement and as they constitute such a large part of the concrete it follows that they should be the best to be obtained in the locality if good work is expected. This is I think if possible of more importance than the determination of the proper proportioning of the ingredients, for the reason that the proportioning has been worked out by experiment for most classes of work and the results are followed by the majority of engineers.

With proper cement and aggregates it is yet possible to get an inferior concrete by improper mixing. After all the material is in the drum of the mixer, mixing should continue for at least one minute and the revolutions of the drum should not be less than 10 nor more than 16 per minute.

Care should be taken in placing the concrete so that separation of the aggregates may not take place and the concrete should be well rammed in place to fill up all voids and pockets. Care is then needed in protecting the work from the elements for a short time.

The Ontario Legislature will place itself on record this session in support of the St. Lawrence Deep Waterways scheme. The matter was drawn to the attention of the House by P. Wellington Hay, who said that, in view of the importance of the matter, the Premier might give the members a statement of the Government's intentions in regard to the matter, if it had any. Mr. Drury spoke of the deep waterways scheme as one which was not yet in the realm of practical politics, though he hoped it soon would be. In voicing his personal opinion he said he believed thoroughly in the project.

Engineer's Library

SEWAGE DISPOSAL FOR FARMS

Reviewed by
Hector S. Phillips

Assistant City Engineer, Hamilton, Ont.

SANITATION AND SEWAGE DISPOSAL FOR FARM-STEADS AND COUNTRY ESTATES — By Dr. William P. Gerhard, Consulting Engineer, New York City. Published by the author, 17 West 42 St., New York; 12 pp., 6 by 9 in., no illustrations, no cover; price, 30 cents.

Dr. Gerhard has written a valuable and authoritative essay on rural sanitation, divided into two parts, the first containing a few statistics showing the great need of efficient health measures on farmsteads and a criticism of primitive sewage disposal devices, and the second a brief but complete discussion of "really sanitary methods of sewage disposal," namely, (1) dry disposal systems, (2) liquefying or biological systems, (3) chemical systems and (4) water-carriage system.

The author has drawn a picture of the modern and progressive farmer enjoying the benefit of good roads, daily free mail-delivery, telephones, farm tractors, and possibly a motor truck; and in the house and barns, sundry mechanical appliances, probably operated by electric current; and, most important for business progress and social betterment, the availability of running water.

He deplores, however, the fact that even on improved farms, there are few model or even tolerably safe and sanitary waste-disposal systems in spite of the amount of sound information and advice available on the subject.

Much of the matter is not new, but Dr. Gerhard points out the menace of the so-called pit privy, and condemns in very strong language the recommendation contained in some health bulletins for its use in cases where the water-carriage system of plumbing has not yet been introduced. It is described as a primitive device, embodying dangerous and unsanitary features, and representing an unsafe and undesirable accumulation of organic matter in a slow process of decomposition, with the fluid leachings possibly reaching distant wells or springs.

Full appreciation of the benefit of domestic sanitation has not yet been reached by farmers and in rural districts, owing to the difficulty of educating isolated farmer communities on these lines.

This pamphlet should be of interest to all connected with rural sanitation.

SEWAGE DISPOSAL

Reviewed by
R. O. Wynne-Roberts
Consulting Engineer, Toronto.

SEWERAGE AND SEWAGE DISPOSAL, by Leonard Metcalf and Harrison P. Eddy. First Edition, 567 p.p. 6 by 9 in. Cloth. \$5.00 net. Published by McGraw-Hill Book Co. Inc., New York.

This is text book for class use in engineering schools. The authors wrote the well-known treatises on American Sewerage Practice in 3 volumes, in 1914-15 and this text book is an abridgement with certain new matter inserted. This text book is worthy of the authors and will doubtless meet the wants of students (young and old) who have not the leisure to peruse the larger treatises. There are 21 chapters in the book, dealing with various phases of sewerage engineering. The first chapter discusses general features and gives a list of terms with interpretations. These are important because we often hear terms applied incorrectly and this leads to confusion.

The second chapter treats on the subject of quantity of sewage, estimating the growth of population, density of population, water consumption, fluctuation in flows and so

on. One criticism can be made in respect to the examples given and that is they are all based on large American cities. In as much as the text book will be used by students, it is very improbable that many of them will have the opportunity of applying the knowledge gained. Personally I believe it is desirable to impart information as it concerns the smaller towns which are very much larger in number and the difficulties are perhaps relatively more numerous and less easy to surmount.

The third chapter deals with storm water and here we must acknowledge that the lack of general investigations by engineers tends to make the solution of the problem of estimating the volume of storm water depend largely upon the judgment of the engineer. The run-off from different surfaces necessarily depends upon their characteristics, grades, seasons. Whilst 80 per cent. run-off may be anticipated under certain conditions, one eminent engineer recently cited an example where sewers designed to carry off 40 per cent. run-off under apparently similar conditions have sufficed.

The analytical method adopted by Metcalf and Eddy and sometimes called the rational method, is the one to be commended. It is interesting to note that the maximum intensity of rainfall in the eastern portion of the United States and Canada is approximately alike.

In the fourth chapter, on hydraulics of sewers, there are a number of interesting matters referred to such as minimum grades, compensation for curves, etc., which deserve close attention. The succeeding chapters, V, VI, VII and VIII deal with matters relating to construction, preliminary investigations and so on. Chapter IX discusses the chemical and biological characteristics of sewage. Chapter X deals with the sewage disposal by dilution and mentions what is necessary to provide for adequate oxidation of the organic matters and the avoidance of objectionable results.

Chapter XV deals with sludge. The principal question which concerns engineers is how to produce sludge which will de-water rapidly for quick disposal. Several methods are discussed. The Birmingham experiment in the production of gas to operate engines is an interesting development not referred to.

Chapters XI, XII and XIII describe grit chambers, screens, sedimentation and Imhoff tanks. The chapter on activated sludge process contains useful information, although no reference is made to Howarth or Bury methods of aeration.

Filters and beds are described in chapters XVI, XVII and XVIII and treatment in chapter XX. Cost estimating occupies the last seven pages. The index extends over twenty-one pages and is full. There are several examples of calculations given for the guidance of students. This text book is an excellent addition to our library and whilst it is primarily intended for students in engineering schools, it will be found useful in offices.

HOGG WAGE TABLES. Published by James O. Hogg, Jr., & Co., Box 416, Kansas City, Mo. This volume comprises a set of 59 rate tables worked out for every quarter-hour from one to sixty and three-quarter hours and at rates per hour running from thirty cents to one dollar and a half and will be found of great value to contractors. They have been compiled by a man who having served his time as a timekeeper on construction work and never having been able to find a practical set of wage tables for this class of pay rolls, and after seeing these same pay rolls come in from out of town jobs in rather confused shape, proceeded to get out this set of tables which have since been brought to a state of perfection and found to be of very great service to time-keepers in the field. The book is in convenient form, bound in leather and thus able to withstand the hard usage it is likely to receive when on the job. These tables have been checked and re-checked and then photographed from the original tracings thereby eliminating all possible errors from typesetting. The book costs five dollars and will be found a real time-saver.

Letter to the Editor

LIBRARIES FOR RESEARCH WORKERS

Sir,—Having, on several occasions, given some thought to the above subject, I believe that the following suggestions may be of use in securing results which, at least, would do for a start; it would then be much easier to approach the Government with concrete proposals, and the ability to show results already accomplished would be of great value in inducing the Government to give assistance.

There must be, in every city, a considerable number of scientific and technical books and magazines, which, if only their location were known to research workers and technical men generally, would be of great service to them.

Take, for example, the case of Toronto, the following institutions possess libraries composed largely of works of the kind referred to:—

The Engineers' Club.
The Royal Canadian Institute.
The University of Toronto.
The Works Department of the City of Toronto.
The Hydro-Electric Power Commission of Ontario.
The Toronto Hydro-Electric System.

I have no doubt others might be found which could be included in the list.

At present these libraries act together independently of each other and I have reason to believe that their systems of cataloguing are all different from each other. So far as I can see there is no reason why, with a little co-operation, all these libraries should not, practically, be one of the great advantage of all those interested in the class of books which they contain. All the books in each library, could at comparatively trifling expense, be classified and catalogued under one uniform system, using a card "title" catalogue and a card "author" catalogue.

The Dewey Decimal System, which is used in the public libraries in Toronto, and, in fact, in most of the great libraries of the world, and which was exhaustively described in the "Canadian Engineer", could be used for the classification; this would link up the small libraries referred to above with the Toronto Public Reference Library on College Street, and, if need be, with all the public libraries of the province.

If this plan were worked out properly, as I believe it easily could be, the following would be some of its advantages:—

(a) Each individual technical library could keep a card catalogue of the books etc., in all the others, so that a man consulting the list of books at any centre could ascertain whether any book he wanted were available in the city or not.

(b) A good deal of duplication in the purchase of books and periodicals, by individual libraries, might be avoided.

(c) It would frequently happen that a book desired by any one library could be consulted at another before purchasing.

(d) The owners of each library would afford facilities for any accredited technical or scientific man to consult their books, on a proper request being made. The advantage of this would oftentimes be very great.

(e) The compilation of bibliographies of certain subjects would be possible and could readily be understood.

(f) The cost of a scheme such as that proposed would be possible and could readily be undertaken.

(g) The cost of a scheme such as that proposed would be very small and could be covered by a comparatively insignificant subscription from each institution of firm participating in it; even this would be offset to some extent by certain economies which each library could probably effect by taking advantage, whenever possible, of the facilities afforded by the others.

To work the scheme properly it would be necessary to have a trained librarian with headquarters in, say, the Royal Canadian Institute or the Engineers' Club, who would advise and assist the librarians of the individual libraries in the classification of books and other literature whenever necessary, and whose duties would include the proper co-ordination of all the libraries in order to secure the best efficiency.

It is likely that quite a few private firms in Toronto possess small technical libraries of their own, and I have little doubt that, if properly approached, such firms would be very willing to co-operate in a scheme of this kind because it would be a boon to their own technical men and of much value to others.

Many scientists, engineers, chemists, etc., have certain books in their possession, which, while being of no particular value to themselves, would be very useful indeed if made available to those specially interested; no doubt the owners would, in most cases, be quite willing to donate such works to some central organization if it were felt that some advantage would thereby be gained by other men.

Having had a good deal to do with the building up of one technical library in Toronto, I feel that I can write with some knowledge of the very real advantages to be gained by the adoption of some such plan as that given above. This plan is quite feasible and, were a commencement made in Toronto, it would be practicable to extend it along similar lines to other cities in the Dominion, and this even without government assistance, although in the case of Ontario, I believe the Public Libraries Department of the Provincial Government would give any assistance in its power to a properly organized movement.

Personally, I would be very glad to see something done in this matter and am quite willing to help in any way I can to bring about the adoption of some definite scheme.

The opinions of your readers, on this subject, would be welcomed by, Yours faithfully,

A. S. L. BARNES.

Toronto, Feb. 20, 1922.

AID FOR RURAL WATER SYSTEMS IN QUEBEC

IT IS announced that J. V. A. Forget, M.L.A. for Iberville, intends to take up the question of water works systems and filters in the province of Quebec. The reason for the motion is to bring on a debate on the activities of the Superior Board of Health. Mr. Forget claims that of late years, since it got the authority, the Board of Health has been compelling municipalities to alter their water works systems and to install filters, with a view to improving the quality of the drinking water. He wants pure water, but his contention is that in many cases the municipalities against whom these orders are issued are not in a financial position to carry out these obligations. He intends to suggest that the Government give some form of aid, somewhat along the lines of the Good Roads Act, for aiding municipalities to build roads, or some other system which will lighten the burden on the municipalities.

MINING SHORT COURSE AT MANITOBA UNIVERSITY

A SHORT course in mining and geology, for prospectors and others interested in mining, has been opened at the Manitoba University, Winnipeg. The course is being conducted by the department of geology and mineralogy of the University of Manitoba, and all lectures will be delivered Monday evenings at 8:30 in the geology building. Following is a list of the lectures: Monday, Feb. 27, "The Rice Lake Field," by Prof. J. S. de Lury; March 6, "The Extension of the Rice Lake Field Eastwards," by E. M. Burwash; March 13, "The Pas Mineral Belt," by Prof. R. C. Wallace; March 20, "Mine Development," by E. M. Burwash; March 27, "Oil Geology," by Prof. J. S. de Lury; April 3, "Our Building Materials," by Prof. R. C. Wallace.

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ORGANIZATION OF METROPOLITAN DISTRICTS

IN THE Report of the Sub-committee on Sewage, submitted to the American Society of Municipal Improvements, which appeared in February 14 issue of "The Canadian Engineer," some interesting information is given on the organization of metropolitan districts for the control of water and sewerage systems. While it is not a new idea, it is only within the last ten or twelve years that any definite progress has been made in this direction, on this continent. Boards or commissions have been in existence in England for some years, while the Metropolitan Sewerage Board of Massachusetts, the Metropolitan Water Board and the Sanitary District of Chicago, the last mentioned formed in 1889, are the earliest examples of metropolitan districts on this continent. In Canada we have the Greater Winnipeg Water District and the Essex Border Utilities Commission.

The increased attention that is being paid to sanitation and more particularly to the development of pure water supplies, has resulted in the formation of various commissions and sanitary districts. Although these commissions or boards have been formed for practically the same purpose, their organization varies both in regard to the powers delegated to them and also in the character of the personnel. In all cases it appears that the system tried has proved to be the one best suited to the conditions prevailing in the district. The report referred to above covered the districts formed for sewerage or drainage of metropolitan areas and not the drainage of farm areas.

The schemes tried may be classified into four groups, although one of these hardly comes within the definition of Metropolitan District. In this particular group the board or commission is practically a municipal organization, the

board being formed by the city council for the purpose of building sewers within the confines of the municipality. In a second group, may be included boards or commissions appointed by elective officers of cities, county or state, and given certain powers by the municipal or federal bodies governing municipalities composing the district. In a third group may be included the sanitary districts which are complete municipalities in themselves with powers of taxation. They can issue bonds dependent upon referendum and the commissioners are appointed by county or state officers. The fourth group comprises the sanitary districts with wider powers than above mentioned. The sanitary districts in this group are organized as municipalities with power to levy taxes and issue bonds without referendum. The commissioners are elected by direct vote of the people in the district.

Probably the best-known organization is the Sanitary District of Chicago, which comes under the last-mentioned group. The best-known of the Canadian organizations is the Essex Border Utilities Commission, which was formed in 1917 to control the metropolitan district comprising the five towns, including Windsor, Walkerville, Ford, Sandwich and Ojibway. This Commission has unusually wide powers, for it not only has under its supervision the sewerage system, but also the waterworks, board of health, hospitals, parks and town planning. Each of the five towns is represented on the Commission by its mayor and there are also 12 other commissioners, making 17 altogether. Money is provided by issuing debentures and levying special taxes, while the cost of construction and maintenance, etc., is divided in proportion to the benefit received by each town in the District. Another Canadian body is the Greater Winnipeg Water District, which was formed in 1913 for the purpose of providing the people of Winnipeg and surrounding towns and a supply of pure water. The Board consists of the Mayor and Board of Control of Winnipeg and the Mayor or Reeve of the other municipalities included in the District.

The successful operation of a metropolitan district is dependent upon the co-operation of all the municipalities concerned. There is no doubt it has many advantages. In districts where there are several towns or communities taking water from the same source and discharging sewage into the same lake or river, a comprehensive water and sewerage system would seem to be essential. It is rather surprising that more progress has not been made in Canada in this direction, particularly in the provinces of Ontario and Quebec where towns are usually closer together than in other parts of Canada and the districts more thickly populated. Conflicting interests between adjacent municipalities tend to hold up very necessary water and drainage schemes, and much trouble could be avoided in such cases by the formation of a metropolitan district.

NATIONAL RESEARCH INSTITUTE

EFFORT is being put forth again this year by the Honorary Advisory Council for Scientific and Industrial Research to obtain a grant from the Dominion government of \$500,000 for the establishment at Ottawa of a National Research Institute. Last session such a grant was approved by the House of Commons but was defeated in the Senate. It is to be hoped that the added publicity to the work of the Council which has arisen during the past year and the increasing appreciation of its services may result in the money being set aside for this commendable object.

In a recent brochure issued by the Council it is pointed out that a lamentable loss in our national assets will be incurred if the variety of occupation which is necessary to retain the most ambitious scientific workers in this country is not provided. If the specialized scientific investigation that must be conducted to back up our industries has to be carried out in a foreign country, it follows that our investigators must either expatriate themselves to have any share in the scientific up-building of our industries or relinquish altogether any claim to shape them towards the ends desired.

That there are many scientific investigations that can only be undertaken by a central independent body supported by government funds is readily evident when one considers the great variety of researches that are under way or are contemplated in this country. The universities and the government departments are of necessity charged with certain routine work of an instructional or administrative character. To mix up research with such activities would be good for neither and the only satisfactory solution of the problem is the establishment of some such institution as that which has been proposed by the Research Council, viz., a national research institute. The undoubted possibilities of such an institute on the side concerning which much is already known, that is work comparable to that undertaken by the U. S. Bureau of Standards, are very great. It is believed that the returns to industry and to the country at large from the explorative activities in little known fields would many times repay the amount of money now being asked of the government.

IMPORTANCE OF KNOWING COSTS

SOME one has said that the most apt definition of engineering is the "art of doing well with one dollar what any person can do with two." It is almost impossible for an engineer to do this without an intimate knowledge of cost and cost analysis.

The engineer of the present day in order to give the maximum service to his client for expenditure on new work must have a thorough knowledge not only of the theoretical part of the design but also of the methods of construction necessary to give the minimum of cost. There is no question but that this branch of the work of the engineer is exceedingly important. In fact much more important than appears to be realized by many of the profession. Too often the question of cost is left entirely to the contractor who has in hand the construction work. But the engineer who supervises and lays out the work is negligent in his duty to his employer as well as in his own best interests if he does not keep in close touch with the costs of the different elements of the work in hand. Much more necessary it is for him to have such knowledge if the construction is being done by himself for his employer. It is only by obtaining full knowledge regarding costs that he can supervise intelligently. By a slight change in the method of arranging forms for concrete, by a different position for the concrete mixer, or in a hundred and one different ways he will find that he can save money and reduce the cost. There is another indirect effect which this study of costs has. The engineer who frequently has before him the aim of obtaining most efficient results will not be led to needless outlay in the matter of design. He will study each element of the design in its relation to the purpose it must serve and will then choose the material which will do the work as cheaply as possible.

The foregoing statements are not intended as a plea for engineers at the expense of efficiency or durability but rather as a warning against the use of expensive and unnecessary details.

PERSONALS

HAROLD B. FISK, manager of the Walsh Plate & Structural Works, Ltd., Drummondville, Que., was elected as secretary of that company at its recent annual meeting.

GEORGE HOGARTH, M.E.I.C., chief engineer of the Department of Public Highways, for Ontario, has been elected president of the Association of Ontario Land Surveyors.

JOHN WILSON, JR., who for the past fifteen years has been a member of the sales organization of the Dominion Bridge Co., Montreal, or associated companies, has resigned in order to accept appointment as sales manager of the Walsh Plate & Structural Works, Ltd., Drummondville, Que.

H. A. TERREAULT, superintendent engineer of the Montreal Waterworks, has been placed in charge of the

various workshops and yards in the city. He will also supervise the administration of the sewer pumping system.

S. FORTIN, assistant director of public works, has been appointed city surveyor of Montreal, which has the title of the head of that branch of the civic service before the organization of the public works department. By his appointment as city surveyor, Mr. Fortin is duly authorized to sign the official plans of the department, as required by law.

GEO. W. OTTERSON who is now residing in Toronto, having accepted a position as consulting engineer to the Canadian Municipal Equipment Corporation, Ltd., was born February 22, 1864, in Atlanta, Ga. After a long practical experience in mining and dredging, and in the construction of municipal water works, sewage and sewage-treatment plants throughout the United States and also in Hawaii and other United States possessions, Mr. Ottersson went to Alaska in 1897, and spent the following fifteen years in dredging, hydraulic work and mining engineering in that territory.

He returned to the United States in 1912 in order to form a company for the manufacture of improved municipal equipment which he had designed and upon which he had obtained patents, and he formed the Ottersson Auto-Eductor Co. in the State of Washington. Mr. Ottersson recently disposed of his interests in that company, of which he was president, upon a royalty basis. While he will devote the greater portion of his time to the new Canadian company which will manufacture his machines, he also intends to establish a private practice in hydraulic and sanitary engineering in Toronto, making a specialty of the design of grit chambers, and of hydraulic dredging and sluicing and sewage problems.



OBITUARY

HON. GEORGE ROBERT SMITH, M.L.A., died in Thetford Mines, P.Q., on Feb. 20. Mr. Smith was born at Newark, N.J., February 17, 1860, and came to Canada in connection with the mining industry. He was vice-president and general manager of Bell Asbestos Co. at Thetford Mines and vice-president and general manager of the Asbestos Manufacturing Co. of Montreal. He was one of the founders of the Canadian Mining Institute, and at one time its president.

Alberta's coal production fell off nearly a million tons in 1921 while Canada was importing 18,102,610 tons of American coal, according to the report of the Alberta provincial mines branch. Alberta produced 5,927,170 tons last year against 6,908,923 tons the previous year. Production last year was the third largest in the history of the province. Need of regulations standardizing Alberta coal to make it more saleable in Saskatchewan and Manitoba are urged in the report, which also points out that there should be a greater market for Alberta coal on the Pacific slope. Some Alberta coal is now being used for bunkering in B. C. ports, and this business is growing, but Seattle and other ports on the Pacific American slope are using much Australian coal which the Alberta product might displace. Alberta has 331 coal mines, and 90 were abandoned last year.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Copper Cliff, Ont., erection of a school	Mar. 9	Feb. 28
Essondale, B.C., erection of addition to hospital	Mar. 24	Feb. 28
Kitchener, Ont., construction of a pump house and a reinforced concrete pump well	Mar. 13	Feb. 28
Raleigh Tp., Ont., erection of a school....	Mar. 18	Feb. 28

BRIDGES, ROADS AND STREETS

Bridgeburg, Ont.—William M. German, of the firm of German & Brooks, has given official notice of intention to apply for a charter for the Niagara Bridge Co. to construct a bridge over the Niagara River between Port Erie and Buffalo.

Cobourg, Ont.—The Town Council is considering the paving of King St., from William St. to the Eastern end of the town, a distance of 1 1/3 miles.

East Angus, Que.—The Town Council passed a by-law authorizing a loan of \$110,000 towards the new bridge.

Hamilton, Ont.—A highway from the western limits of James Street to the Mountain Boulevard will be constructed at a cost of \$137,000.

Hamilton, Ont.—The question of street widening was dealt with on March 3, at a meeting held by the Town Planning Board at the City Hall by James O'Brien, of Toronto, who is deeply interested in the subject and who recently drafted a bill for deferred street widening for the Toronto Civic Guild, which will be introduced at the present sitting of the Ontario Legislature. The speaker explained that thirteen clauses in the draft bill, pointing out that in the event of this bill becoming law, City Councils will have the authority to fix up street lines, which will become effective at a fixed time between three years from the passing of the by-law, and fifteen years.

Kingston, Ont.—The Board of Works decided to purchase the 1922 supply of cement in the open market.

Kingston, Ont.—A concrete walk will be laid on Dursion St. north of Russell St. Cowdy St. to Stephen St. will be opened up.

Montreal, Que.—In all probability the proposed 3,000,000 highway through the Island of Montreal, to extend from the bridge terminal at Bout de l'Île to St. Anne de Bellevue, will soon materialize and work on this thoroughfare is expected to begin early this year. It is to be built in sections and will be 150 ft. wide.

North Vancouver, B.C.—In an endeavor to bring about the adoption of some definite form of connection between the north and south shores of Burrard Inlet at the Second Narrows, a committee consisting of Ald. F. E. Woodside, Mayor G. H. Morden and Reeve J. Y. McNaught will shortly wait upon the Vancouver Board of Trade Commissioners. This decision was reached at a recent meeting of the Burrard Inlet Tunnel & Bridge Co. A communication to the company from the Strauss Bascule Bridge Co., of Chicago, revealed that a double track bridge could be constructed for

\$1,016,500, while a single-track bridge could be built for \$880,000.

Ottawa, Ont.—Carleton County Council authorized County Engineer T. H. Byrne to make a survey of the road from Hawthorne to the boundary of Russell County, which is to be widened in the near future.

Quebec, Que.—Ivan Valee, chief engineer of the Provincial Department of Public Works, announced that the department is preparing plans for several new bridges.

Quebec, Que.—Orders have been issued by the Provincial Government to continue work on the Drummondville, East Angus St. Alexis and St. Thomas bridges.

Ste. Anne de Beaupre, Que.—It is reported that the municipalities along the highway between Quebec and Ste. Anne de Beaupre have come to a final arrangement with the Provincial Government to raise sufficient money to build a hard surfaced roadway between Beaupre asylum to St. Anne will probably start early in the spring.

St. Catharines, Ont.—Lincoln county spent \$328,863 on county roads and \$109,961 on suburban roads during 1921.

St. Catharines, Ont.—Lincoln County Council passed a by-law providing for the raising of \$240,000 for county road construction, and the raising of \$36,000 for maintenance.

St. John, N.B.—The Railway Commission has ordered the construction of an overhead bridge at the C.P.R. crossing, Douglass Ave.

St. John, N.B.—The Common Council is considering the purchase of a motor flusher, a mechanical ejector for cleaning catch basins, several pieces of apparatus for laying pavements, motor truck and a larger asphalt plant.

Stamford Tp., Ont.—The Township Council will urge the Hydro-Electric Power Commission of Ontario to build certain bridges in the township.

Toronto, Ont.—Specifications will be completed and tenders called at once for the construction of the new Gerard St. bridge.

Toronto, Ont.—The Works Committee passed the project for widening Bloor St., from Sherbourne St. to Spadina Ave. Estimated cost, \$1,500,000.

Toronto, Ont.—The City Council plans the construction of a concrete sidewalk on Marlborough Place, at an estimated cost of \$1,224. Work to commence in the spring.

Toronto, Ont.—The City and Harbor Board will urge the Dominion Government to include an appropriation in next year's estimates for the construction of a bridge to the Island.

Toronto, Ont.—The Board of Control recommended to the City Council that tenders be called for the construction of a bitulithic pavement on Coleman Ave., from Barrington Ave., eastward.

Toronto, Ont.—The Board of Control endorsed and forwarded to the City Council for adoption the recommendation of the Works Committee that Bloor St., between Sherbourne St. and Spadina Ave., be widened to 86 ft., at an estimated cost of \$1,500,000.

Toronto, Ont.—Works Commissioner R. C. Harris recommended the construction of the following pavements: Fairford Ave., from Moxley Ave. to Coxwell, \$24,316; Maughan Crescent, Edgewood Ave. to Robbins Ave., \$16,589; Wabash Ave. from Sorauren Ave. to the east end, \$36,348; and St. Clair Ave., from Cobalt Ave. to Runnymede Road, \$35,348.

Toronto, Ont.—The Board of Control has endorsed and forwarded to Council for adoption, the recommendation of the Works Committee that Bloor Street, between

Sherbourne Street and Spadina Avenue, be widened to 36 ft., at an estimated cost of \$1,500,000, of which the taxpayers in general will contribute \$900,000 and the property owners benefited \$600,000.

Windsor, Ont.—A deputation will be sent to Toronto to interview Hon. F. C. Biggs, Minister of Public Works and Highways, in regard to the possibility of launching the promised government road building program in Essex County with as little delay as possible.

Windsor, Ont.—This city's share of the cost of paying 14 miles of county and Provincial highways in the Windsor suburban area, which extends to Essex, is approximately \$150,000. It is proposed to ask the Provincial Government to complete this work in two years. The city is willing to issue debentures covering its share of the cost.

WATER, SEWAGE AND REFUSE

Chatham, Ont.—The possible reclamation of 1,800 acres of marsh land in the vicinity of Rondeau is being considered. One of the farmers interested in the scheme is said to have purchased 100,000 tile, which he will put in as soon as weather permits.

Chatham, Ont.—The Provincial Board of Health has been called in by the Chatham Water Commission, to investigate the water problem, and to give a statement, regarding the relative merit of Lake Erie and the River Thames, as a permanent source of supply of water for Chatham. It is proposed to spend \$5,000 in alterations to the plant and in experimenting on various processes of filtration. Engineer Dallyn states that after this is done the present filtration plant on the river will be able to produce an absolutely pure and wholesome water at all seasons of the year.

Kingston, Ont.—The Board of Works awarded contract for the supply of castings to T. G. Bishop.

Kirkland Lake, Ont.—By order of the Township Council of Teck, several of the wells which supply the townsite with water are being widened and deepened. The installation of a water system is being considered.

Oakville, Ont.—The Town Council decided to proceed with the installation of an auxiliary pump in connection with the water works system.

Ontario, Province of.—Tenders will be received by the Hydro-Electric Power Commission of Ontario till 1 p.m., April 10, 1922, for widening and deepening the channel of the Welland River and a portion of Queenston-Chippawa power canal. Plans and specifications may be obtained at the offices of the Commission, Toronto or Niagara Falls, Ont. (See official adv.).

Ontario, Province of.—Tenders will be received by the Hydro-Electric Power Commission of Ontario until 1 p.m., April 10, 1922, for construction of concrete intake structure and ship channel in the Niagara River. Plans and specifications may be obtained at the offices of the Commission, Toronto or Niagara Falls, Ont. (See official adv.).

Ottawa, Ont.—Tenders will be called in the near future for the construction of the Emmett street sewer.

Ottawa, Ont.—The Canadian Des Moines Steel Co., Chatham, Ont., has received an order from the city for the building of 2,100 ft. of 51-in. pipe, and 150 ft. of 42-in. pipe, together with special fittings.

Peterborough, Ont.—The new \$300,000 filtration plant is now in partial operation, and the improvement in the quality of water is distinctly noticeable. The plant is being tested out each night, and the day requirements are taken from the two-million-gallon reservoir. This plan will continue until the tuning-up process has been completed to the satisfaction of the contractors and engineers.

Riverside, Ont.—Contract let to Collatti Brothers for the construction of a storm sewer on St. Louis Ave., at an estimated cost of \$2,800.

St. John, N.B.—Plans are being prepared by the City Engineer for the construction of a trunk sewer on Lansdowne and Dufferin Avenues.

Saanich, B. C.—The first of the work on the Gordon Head water extension was authorized recently by the Saanich Council, when instructions were given to at once proceed with the laying of water mains from Telegraph Bay along Windsor Place to Douglas Ave., and thence along to Charles St., and also from the present main end on Ruby Road to Cedar Hill Road, thence to Fulton Road and down Shelbourne St. Reeve Watson, Councillor McWilliam and Clerk Cowper were appointed a committee to secure 12-inch pipe.

Toronto, Ont.—The City Council plans the construction of a sewer on McCaul St., at an estimated cost of \$3,810, and another on Walpole Ave., at an estimated cost of \$2,670.

Toronto, Ont.—The City Council plans the construction of a 6-inch water main, for Ingram Ave., a length of 214 feet, at an estimated cost of \$723.08, and a length of 321 feet, at an estimated cost of \$1,077.03, for Lightbourne Ave.

Vancouver, B. C.—City Council let a contract to the Vancouver Engineering Works for the supply of 18-in. riveted pipe for making the connection on Bodwell Road, between Laurel St. and the reservoir. Their tender was \$3.20 per lineal foot, or a total of \$7,251.20.

LIGHT, HEAT AND POWER

Brandon, Man.—Representatives of Brandon City Council and Brandon Board of Trade have requested the Manitoba Legislature to make an appropriation at the present session for the extension of the hydro-electric lines to Brandon.

Bridgeburg, Ont.—A motion will be introduced in Council that steps be taken to bring Hydro power here while its line to Stevesville is being constructed.

Cobalt, Ont.—Work on the new power development for Porcupine is being rushed. The present plans are to complete the 28-mile transmission line within three months, and to turn back the current from the present power houses to assist in the construction of the new power house at Sturgeon Falls.

Fort William, Ont.—The Hydro-Electric Power Commission has signed a contract to supply Nipigon power to the Consolidated Elevator here. The contract calls for the delivery of between 500 and 600 h.p. The construction of a line to the Consolidated plant means that several other elevator plants in the vicinity will be able to secure power.

Winnipeg, Man.—The following prices were received by the local Hydro-Electric System for 100,000 ft., more or less, of 3 1/2-in. fibre conduit: Filer Smith Machinery Co., 9.28c per ft. for Orangeburg Fibre Co. product; Northern Electric Co., 11.07c per ft. for American Fibre Co. product; Canadian Johns-Manville Co., 9.5c per ft.

RAILWAYS

St. Thomas, Ont.—It is reported that the Wabash Railway Co. is planning the erection of locomotive repair shops in this city in the near future, at a cost of approximately \$500,000.

Toronto, Ont.—Following a conference of representatives of York Township Council, the Toronto Transportation Commission and the Ontario Railway and Municipal Board, it was decided that York Township Solicitor Spence should meet the solicitor for the T.T.C. to draft legislation covering the extension of street car lines into York Township.

Windsor, Ont.—According to a statement made recently by Hon. W. C. Kennedy, Minister of Railways and Canals, there is no possibility of the Grand Trunk yards here being electrified, owing to the expense of such work.

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Extension to Shawinigan Hydro - Electric Plant

New 41,000-H.P. Unit Has World's Largest Steel Casing and Biggest Valve Ever Built — Foundation Slab is 12-Ft. Thick, 52-Ft. Space — Paper Read at Last Annual Meeting of Engineering Institute of Canada

BY JULIAN C. SMITH

Vice-President and Chief Engineer, Shawinigan Water & Power Co., Montreal

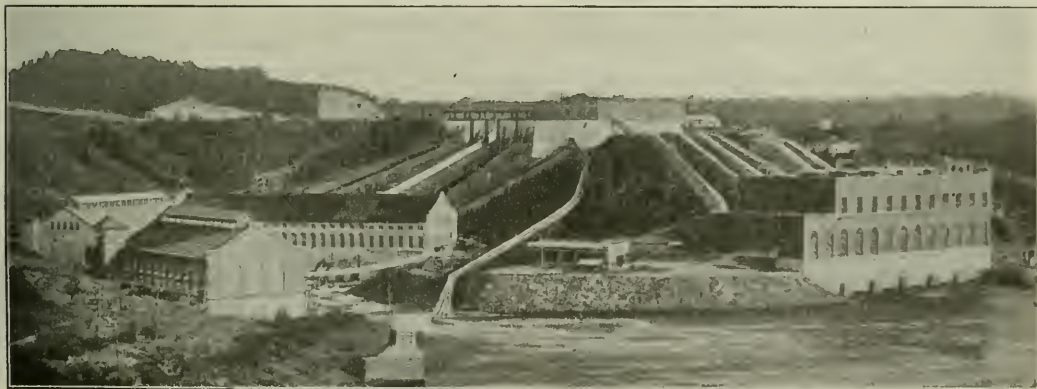
IN PRESENTING a description of the latest hydro-electric development at Shawinigan Falls, it is the writer's intention merely to describe briefly those features of design and construction which, because of their departure from more usual practice, are worthy of attention.

The rated capacity of the waterwheel of the new unit is 41,000 h.p., and the wheel will operate at 138.5 r.p.m. under a head of 145 ft. The art of manufacturing wheels has advanced rapidly during the last twenty years. The first wheels installed at Shawinigan in 1903 were rated at 6,000 h.p. at 180 r.p.m., and were the largest wheels that could be built at that time. By the time of the second

ranted. The total flow for the full capacity of 220,000 h.p. at existing load factor for the two power houses at Shawinigan Falls will be about 12,000 cu. ft. per second.

Forebay Extension

The forebay extension begins on the downstream side of the bridge and is carried in a straight line to the end of the bulkhead extension. Excavation in this part of the work has been begun and will be carried in the dry as closely as possible to the existing crib. After the bulkhead and the new crib are completed and as much of the rock taken out as possible, the extension will be flooded



POWER HOUSES NOS. 1 AND 2, SHAWINIGAN FALLS — EXTENSION TO NO. 2 IS BEING CONSTRUCTED AT EXTREME RIGHT OF PHOTO

development at Shawinigan, in 1910, it was possible to install horizontal double-runner turbines with a rating of 18,500 h.p. In 1922 there are wheels of 52,000 h.p., and the Hydro-Electric Commission of Ontario are considering for their Queenston installation waterwheels having an even greater capacity.

In order to provide the water for the unit at Shawinigan, about 3,000 cu. ft. per second additional flow is required. The existing canal through which the water flows to the head-gates is 160 ft. wide by 35 ft. deep. It is restricted to this width at the upper end by the bridge which carries the railroad spur and roadway giving access to the power house. Owing to the fact that the velocity of the water in the canal will be increased only about 25%, or to $3\frac{1}{4}$ ft. per second, which is not excessive, it was decided that the expense of widening the canal, which would necessitate an additional bridge span, was not war-

and the old crib and remaining rock will be removed by dredging.

Gatehouse

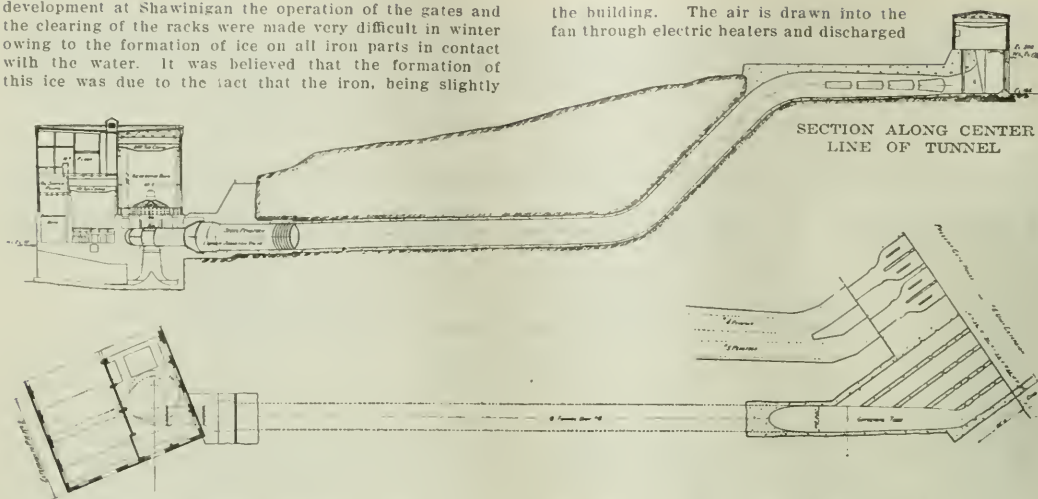
The extension to the gatehouse is very similar in detail to the existing building. It is 80 ft. long and contains five sluiceways, each 12 ft. wide, the same width as the sluiceways in the existing building, thus enabling the same stop-logs and similar gates and racks to be used. It is not intended to instal gates at present, as it is hoped to regulate the flow by the Larner-Johnson valve. However, grooves will be left in the concrete so that gates can be installed later if necessary.

Prevention of Ice

One of the features of the 1910 development at Shawinigan Falls was the provision for prevention of the forming of ice on the racks. In the early days of the power

development at Shawinigan the operation of the gates and the clearing of the racks were made very difficult in winter owing to the formation of ice on all iron parts in contact with the water. It was believed that the formation of this ice was due to the fact that the iron, being slightly

the building. The air is drawn into the fan through electric heaters and discharged



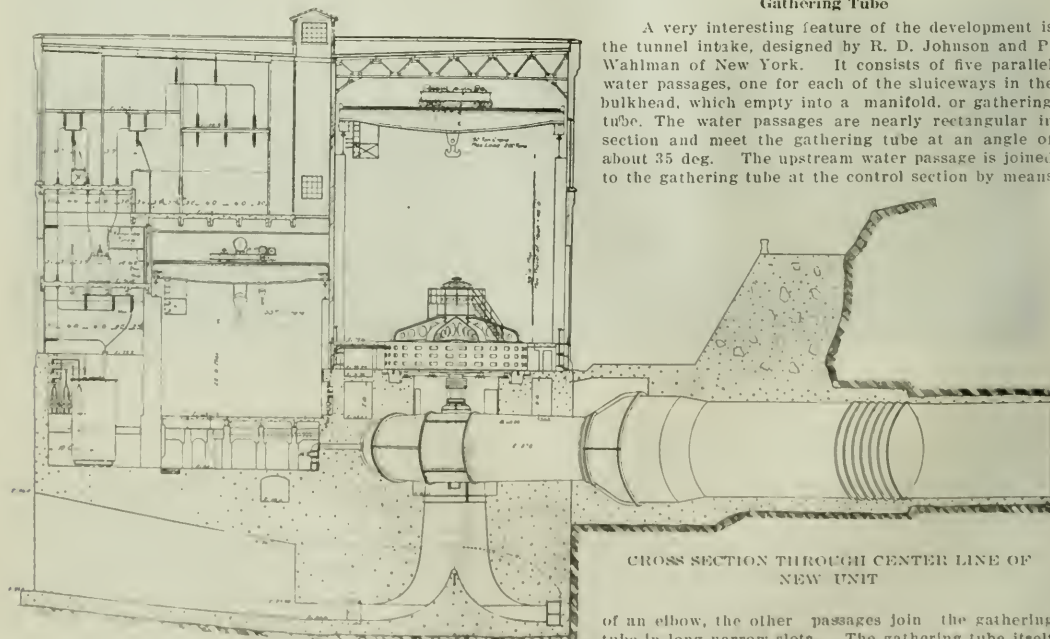
GENERAL PLAN SHOWING TUNNEL AND EXTENSION TO BULKHEAD AND POWER HOUSE.

colder than the water, conducted heat away from the water thus causing the formation of ice on the iron. In order to raise the temperature of the iron slightly, large air ducts are provided in the gatehouse floor, extending the entire length, with laterals across the building into the chambers leading to the penstocks, so that air can be discharged into these chambers and blown down against the racks.

at a temperature of 150 deg. F. into the main duct. Since the installation of this system there has been no ice formation inside the building and no tendency of the ice in the water to stick to the rack bars. Further, the ice has not formed around the gates and consequently no difficulty has been experienced in operating the head-gates in the most severe weather.

Gathering Tube

A very interesting feature of the development is the tunnel intake, designed by R. D. Johnson and P. Wahlman of New York. It consists of five parallel water passages, one for each of the sluiceways in the bulkhead, which empty into a manifold, or gathering tube. The water passages are nearly rectangular in section and meet the gathering tube at an angle of about 35 deg. The upstream water passage is joined to the gathering tube at the control section by means



CROSS SECTION THROUGH CENTER LINE OF NEW UNIT

This heating system is being extended to serve the addition to the gatehouse, as it has been found that the system is very efficient. A fan with a capacity of 60,000 cu. ft. of free air per minute is located at the far end of

of an elbow, the other passages join the gathering tube in long narrow slots. The gathering tube itself is circular in section, 20 ft in diameter, at the downstream end where it meets the tunnel, and tapering to 13 ft. 4 in. in diameter at the upstream end or control section.

The function of the intake is to cause a uniform flow

of water in each of the five sluiceways and to discharge the water into the tunnel with a minimum of disturbance. The hydraulic theory of its operation is roughly as follows:

In order to fulfill the hypothesis on which the design is based, the flow from the water passages into the gathering tube must be uniform per unit of length.

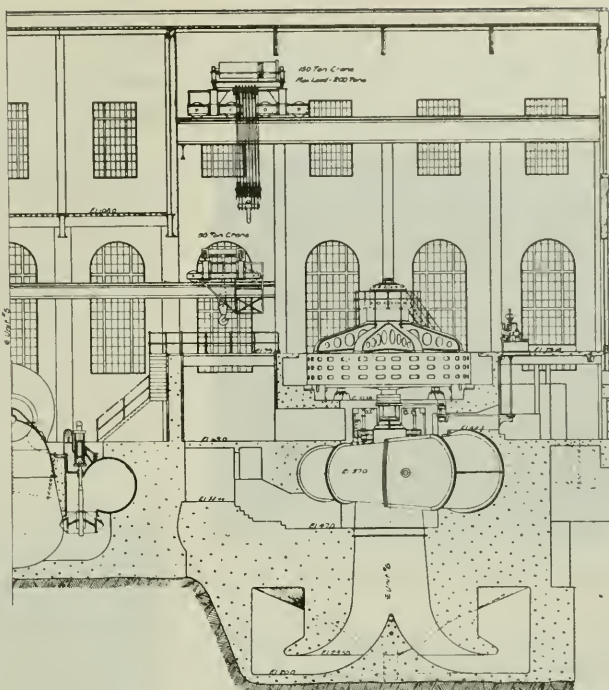
The diameter of the gathering tube at any section was fixed by making the quantity of water flowing at that section proportional to the square of the velocity; that is, at any point in the gathering tube Q/V^2 is a constant. This relationship was decided on after some study, as giving the most economical dimensions for the gathering tube.

At any point beyond the control section in the gathering tube, the water arrives from two sources, a small part of it from a section of the slot adjacent to the point considered, and a large part from the gathering tube itself. The difference between the loss of head which has accumulated in the gathering tube up to this point and the loss which has accumulated in the water passage must be just large enough to cause the required quantity of water to flow through the slot.

When losses up to the point under consideration have been determined, the depth of slot at that point can be calculated.

The friction loss was based on a coefficient of 130 in the Hazen and Williams' formula, which is equivalent to about $N = 0.12$ in Kutter's formula, and the coefficient of discharge for the slots was taken as 0.98.

The total loss of head in the intake has been estimated to be 4½ in. for a distance of 2,940 sec. ft. This loss may seem rather large at first sight, but the complication



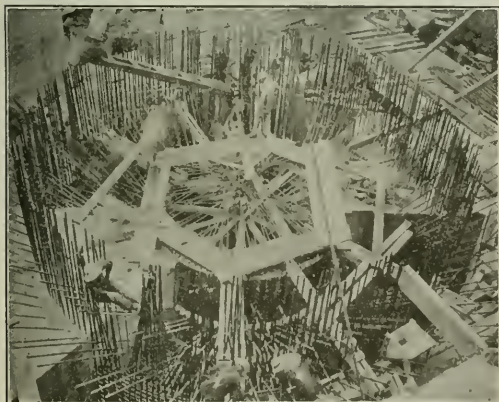
GENERAL LONGITUDINAL SECTION, EXTENSION TO NO. 2 POWER HOUSE, SHAWINIGAN FALLS

a little head to insure nearly uniform distribution of flow through the racks, in the belief that the total loss will be less than would ordinarily be the case with high local velocities through them.

It is interesting to note that the uniformity of distribution is not to any material extent, within reasonable limits, a function of the quantity of water drawn through the intake, so, with the dimensions determined for the maximum draft, the distribution will remain practically uniform for other quantities drawn.

A little study of the problems involved in the design will indicate that the forces dealt with are very small, yet their relation to each other is the only consideration upon which reliance can be placed to secure the desired distribution of flow. A slight variation of the dimensions determined may cause a noticeable unbalance of distribution. This was well shown in a model which was constructed for us by the I. P. Morris Co., and tested in their laboratory. At the first run it was found that the flow was unbalanced, especially between the first, or upstream, and second sluiceways. The model was emptied and the dimensions checked up and it was discovered that the throat of the control section was a little too large. This was corrected by placing fillets ¼ in. thick, top and bottom, in the throat, and the model was again tested, with the result that a uniform flow was obtained in all five sluiceways. The scale of the model was 1/15 full size, so these ¼-in. fillets would correspond to a little less than 2 in. in the full-sized tube.

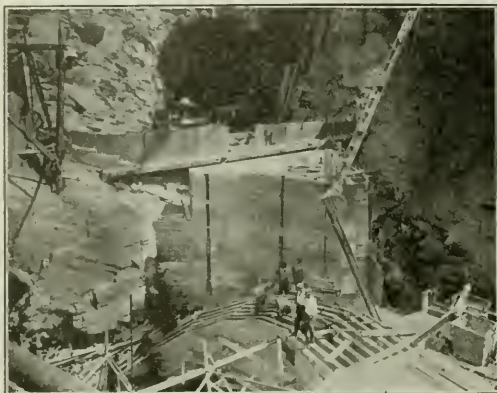
The water passes from the gathering tube into a tunnel, 20 ft. in diameter, which delivers it to the steel penstock at the bottom. The tunnel was chosen in preference to a steel penstock for economy both in construction and upkeep. The completed portion of the tunnel has cost less than \$370 per foot, whereas the steel pen-



REINFORCING IN PLACE FOR FOUNDATION SLAB, 12 FT. THICK, 52-FT. SPACE

of the design necessary to effect a material reduction did not appear to be warranted by the gain in energy, and the assurance of getting even distribution of flow would be reduced. It was thought proper, therefore, to sacrifice

designed to take care of the static head plus the surge. The allowance for surge at the lower end amounts to a little more than the static head, the combined pressure being 126 lbs. per square inch. In other words, the tunnel at the bottom is reinforced to take care of a bursting stock, which connects the tunnel to the Larner-Johnson valve, will cost erected about \$450 per foot.



CONCRETE POURED TO ELEVATION OF TUNNEL—PORTAL AT SOUTHEAST CORNER OF POWER HOUSE

The tunnel is lined with concrete averaging about 2 ft. in thickness, which is reinforced throughout its length. The reinforcement for some distance from each end was pressure of 3,600,000 lb. per foot. This reinforcement consists of hoops of 1 1/4-in. diameter bars, spaced 3 in. on centres at the lower end of the tunnel, 12 in. on centres in the central part, and 6 in. on centres at the upper end. The hoops are tied together longitudinally by 3/4-in. diameter bars about 2 ft. on centres, which act as spacers and as temperature reinforcement.



TUNNEL, LOOKING TOWARD POWER HOUSE—POURING CONCRETE IN FIRST 100-FT. SECTION

A section of steel penstock, 77 ft. long and 20 ft. in diameter, connects the tunnel with the Larner-Johnson valve. This penstock is built of 1 1/4-in. plates and is anchored into the tunnel by means of seven rings of 4 by 4

by 3/4-in. angle, which are rivetted to the plates. These rings will also serve as seals to prevent leakage along the penstock.

The loss of head in the tunnel and penstock, using a coefficient of .012 in Kutter's formula, will be about 0.7 ft., so that the total loss of head up to the turbine will be about 1.1 ft.

The rock through which the tunnel was driven is a very hard granite, compact throughout the length of the tunnel except at the upper end near the surface, where faults were encountered.

The tunnel was driven from the lower end in the



usual manner, by first driving a heading 10 to 15 ft. ahead of the face and then shooting down the roof. Most of the mucking was done by a one-yard, motor-driven. Thew shovel of a type especially designed for this kind of work. The muck was loaded by the shovel into skips, hauled to the portal and hoisted by derricks either to the crusher platform or to dump cars which carried it to the spoil bank.

Owing to the hardness of the rock, the cost of tunnel excavation was high, averaging \$7.22 per cubic yard. The

cost of drilling and blasting alone was half of this amount, the balance being made up of handling, loading, hauling to dump and pumping.

After the excavation was completed, the invert for the lining was placed, beginning at the upper end and working towards the portal, the bottom being cleaned out and the tracks removed just ahead of this work.

The forms were then erected on the invert and the upper part of the lining concreted, beginning about 30 ft. from the portal and working towards the upper end.

The forms for the straight portions of the tunnel were made of 2-in. B.C. fir lagging supported on structural steel ribs spaced 2 ft. 6 in. on centres. The lagging was delivered to the job in 10-ft. lengths and dressed to a 10-ft. radius like the staves of a tank. The steel ribs were composed of two 6 by 3½-in. angles back to back, and were anchored to the rock by means of 1-in. bolts so that no internal bracing was required, and the whole interior of the tunnel was left clear for the dismantling and carrying ahead of the forms as the work progressed.

The concrete was mixed at the upper end of the tunnel and delivered by means of a chute to a hopper part way down the slope. From the hopper it was fed into a pneumatic mixer which forced it under 200 lb. pressure through an 8-in. pipe into the forms. This meth-



INTERNAL C. I. CYLINDER FOR 20-FT. JOHNSON VALVE BEING FACED ON 18-FT. VERTICAL BORING MILL

od of placing the concrete gave us a very dense lining, with a remarkably smooth surface.

The forms for the tunnel elbows were built outside on a platform near the carpenter shop and there lowered into the tunnel in sections about 5 ft. long.

In designing the power house superstructure the details of the existing building were followed as closely as possible and the only marked differences are in the elevation of the operating floor and in the height of the new generator room.

The extension is 80 ft. long and the same width and height as the old building, that is, 115 ft. wide by 75 ft. high.

The new unit occupies the upstream part of the extension, the generator room being 50 ft. wide by 80 ft. long and the full height of the building. It is served by a crane, the trolley of which is designed to lift 200 tons and the bridge for a load of 150 tons at either end or 200 tons at the centre.

The operating floor of the new units is 16 ft. above the operating floor in the old part of the building.

The downstream part of the extension will be served

by the 100-ton crane that serves the old generator room.

The Moody draft tube in the substructure of the extension presented a number of difficulties both in design and in construction. The principal difficulty in design was in connection with its reinforcement.

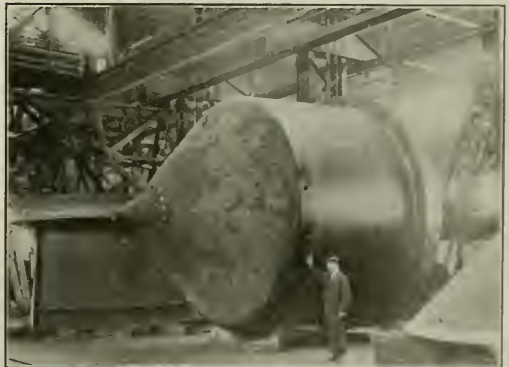
The draft tube block can be described as a flat plate with a circular hole in the middle, the bell of the draft



WORLD'S LARGEST STEEL CASING FOR HYDRAULIC TURBINE — PARTIALLY ASSEMBLED AT DOMINION ENGINEERING WORKS

tube being suspended from the bottom of the plate. The walls supporting the plate are roughly in the shape of a horseshoe, 52 ft. in diameter and 48 ft. between the points. The plate is 12 ft. thick. The total load, including the weight of the block, is something over 12,000,000 lb. The problem was to reinforce this block in such a way that it could be poured in sections not exceeding 250 cu. yd., which was about a day's run for the mixer.

The most obvious method of reinforcing it was to run bars in two directions at right angles to each other, as in an ordinary flat plate. This method, however, was found to be impracticable on account of the fact that there would have been required four layers of 1½-in. bars on 6-in. centres each way, which would have meant a total of eight layers where the bars crossed, or a network of bars 4 ft. deep like a stack of 6-in. mesh sieves. It does not require a very vivid imagination to picture the kind of



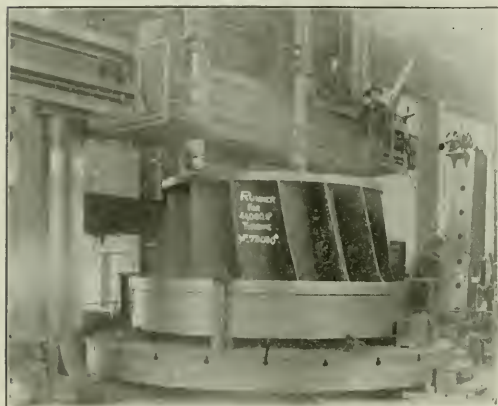
C. I. PLUNGER FOR 20-FT. JOHNSON VALVE—WEIGHT, 46,000 LB.

concrete that would have been obtained at the bottom of that mass of steel.

The method used was, therefore, decided upon as most nearly complying with all of the requirements. It

consists of hoops and vertical bars placed near the outside of the bell, horizontal bars placed radially at the bottom of the plate and diagonal bars to take care of the shear or web stresses. The part of the block between the points of the horseshoe was reinforced as a beam in order to provide support for the plate on that side.

In this system the bars are in comparatively short



RUNNER FOR 41,000-H.P. TURBINE—BEING MACHINED ON BORING MILL

lengths and easy to handle. There are at most two layers of bars vertically and they do not cross to form a grid and construction joints can be formed on practically any radial line, as there is no shear on the radial planes.

The stresses were limited to 12,000 lb. per square inch tension in the steel, 500 lb. per square inch compression in the concrete, and 50 lb. per square inch bond stress.

In designing and constructing the formwork a great deal of care was taken to prevent deflection of the forms and to ensure smooth surfaces for the water passages. The construction of the draft-tube bell particularly was a very intricate piece of work and required the services of several pattern makers. The ribs for the bell were all cut and shaped in the shop and the whole assembled before being set in place. We have been amply repaid for the care taken in this regard by the smoothness of the finished surfaces and the resulting accuracy of line and grade, which will make the assembling of the machinery merely a matter of setting in place.

Larner-Johnson Valve

The Larner-Johnson valve which is being manufactured for this development at the Dominion Engineering Works is the largest valve that has ever been built. It is about 23 ft. in diameter and 27 ft. long, and weighs approximately 150 tons. The moving part of the valve alone weighs 25 tons.

The valve will be located in a chamber outside of the power house, between the 20-ft. diameter penstock and the turbine casing. It can be operated either in the valve chamber or by means of a three-way valve at the generator control board.

The valve consists of a bell-shaped, cast-steel shell, 22½ ft. inside diameter, tapering to 13 ft. diameter at the outlet, a cylinder inside the shell, 16 ft. in diameter, which is rigidly attached to the shell and has a conical head pointing up-stream, and a plunger which slides in the cylinder. The plunger terminates in a conical nose.

Between the cylinder and the plunger there is an annular chamber, sealed at one end by a ring attached to the plunger and at the other end by a ring attached to

the cylinder. These rings are lined with brass and serve as guide bearings for the plunger.

The valve is hydraulically operated by a differential pressure on the two sides of the plunger. When the valve is open and balanced, the cylinder and the annular space between cylinder and plunger are under the full penstock pressure and of course the penstock pressure is exerted on the nose of the plunger. To close the valve the penstock pressure is maintained in the cylinder and the pressure in the annular chamber is released. This causes the plunger to move forward and closes the valve in a manner similar to the action of a needle valve. An automatic damping device slows down the motion of the plunger as it nears the valve seat.

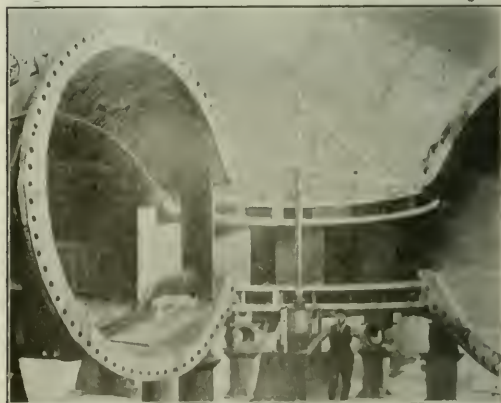
To open the valve the operation is reversed. Water is admitted to the annular chamber under penstock pressure and the pressure in the cylinder is released.

The pressure in the cylinder and in the annular chamber is controlled by means of three 12-in. Larner-Johnson valves so arranged and connected that the large valve can be balanced in any position from closed to full open.

Selection of Type

When the second hydro-electric development was made in Shawinigan, in 1910, the horizontal type of unit was adopted, and the 18,500-h.p. double-runner turbines then installed were among the largest machines to be built at that time. It was then assumed that the ultimate development at this plant would be carried out with this type of machine. When, however, the demands for additional power necessitated an extension of the plant in 1920 and a careful study was made of the more recent development of turbine manufacture, it was decided to adopt the vertical type of unit as being the most economical machine to produce the required power.

It is not necessary here to compare at length the relative merits of vertical and horizontal units. In adopting the vertical type of machine for this installation, consideration was given to economy of space and material. The centre-to-centre spacing of the three 41,000-h.p. machines which will be the ultimate development at Shawinigan, is 60 ft. The centre-to-centre spacing of the present 18,500-h.p. units is 40 ft., so that there is a decided saving of space with the new vertical units. The dimen-



CAST-STEEL CASING PARTIALLY ASSEMBLED — ENTRANCE SECTION REMOVED TO SHOW GUIDE VANES

sions of the vertical machines are such that an extension of the present power house on the same dimensions affords ample room. In fact, were it not for the necessity of extending the present crane runway, the downstream side of the power house could be narrowed considerably in the extension.

The problem of bearings for vertical units has been successfully solved by more than one manufacturer, and this objection to the vertical type of construction no longer exists. The advantages of weight and low mechanical stresses are on the side of vertical machines, so the change from horizontal to vertical units in this power house was amply justified.

Rating and Characteristics

The rating of the generator is 30,000 k.w. at 75% power factor, which is equivalent to 40,000 k.v.a. The power will be generated at 11,000 volts, 3 phase, 60 cycles and the machine will operate at 138.5 r.p.m., being designed with 52 poles.

The short-circuit characteristics of the machine are such that the instantaneous short-circuit current will be 3.3 times full load current, and the sustained short-circuit current at normal excitation will be equal to twice full load current. It is interesting to note that with the high internal reactance necessary to give these results the short-circuit current on light load and correspondingly light excitation will not exceed one-half full-load current.

The stator coils are form wound and the mica insulation is put on in the form of tape. The coils under test have withstood a break-down voltage up to 59,000 volts on the average. The full-load regulation of the machine at 100% power factor will be 15%; and at 90% power factor, 28%.

Mechanical Features

The rotor is of cast steel and is built to withstand the stresses which would be developed at double normal speed; that is, at a peripheral velocity of 21,800 ft. per minute.

To facilitate handling, the rotor is constructed in six parts; that is, there are three horizontal sections which are split vertically along the axis of the shaft. When the rotor is erected the two halves will be assembled on the shaft and then drawn together with 36 bolts, which will be shrunk in place. Each pole piece weighs about one ton and is dovetailed into the rotor and secured by wedges and a retaining ring at top and bottom, as is usual in this type of construction. In order to reduce windage, the spokes of the rotor are encased with steel plates. The generator rotor and turbine runner are mounted on separ-

able disc. This construction of the lower disc insures a practically uniform distribution of the weight over the surface of the bearing. The oil flows from an elevated tank up along the shaft and is drawn through the bearing by the centrifugal action of the rotating disc. The lubricating oil is cooled by a water coil which keeps the temperature of the oil below 55 deg. C. and enables



ASSEMBLY OF GUIDE VANES ON POWER DISTRIBUTOR RING

the bearing to operate with the exceedingly small oil circulation of about 4 gal. per minute. The bearing is required to carry the weight of the rotor, the turbine runner and the hydraulic thrust, which in this unit amount to about 723,000 lb.

Brakes

In order to bring the machine to rest in a short time when desired, a combination of air and oil actuated brakes is provided, which operate on the underside of the rotor. The air pressure required for these brakes is 100 lb. per sq. in., and a separate oil pressure pump is provided so that the brakes can be used as lifting jacks to raise the rotor.

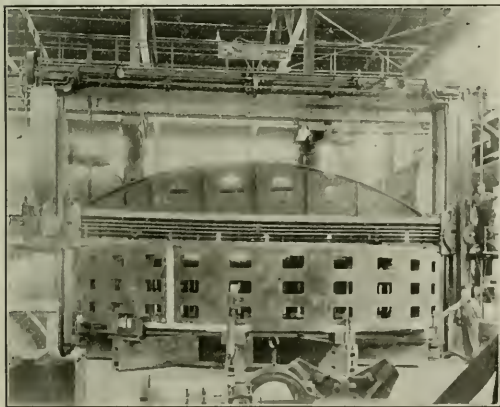
Structural Features

The structural features of the unit have been so arranged that the operating floor is level with the top of the generator frame instead of with the base as is customary. This arrangement has several advantages as it not only tends to lessen the windage noises but permits the control of the warm air discharged from the generator. The cooling air, which amounts to 100,000 cu. ft. per minute, is drawn from the wheel pit through radial tunnels and may be discharged from the generator outside the building in the summer, or into the operating room in the winter when warmth is desirable.

The control apparatus for the generator and turbine will be located on the generator room floor. It is worth noting that in modern station design there is a tendency to place the control apparatus on the operating floor. This reversion to the arrangement followed in the original hydro-electric stations is made possible by the design of enclosed and quiet running machines.

Electrical Connections

The keynote of the electrical connections has been simplicity. Each generator will be connected directly to the low-tension side of its transformer bank without any intermediary oil-circuit breakers, which virtually makes each generator and its transformer bank one unit. The 11,000-volt cables from the generators to the transformers are carried in fibre conduits. There are nine single-phase cables per unit, arranged with the three cables of each phase in a vertical plane. This arrangement gives the



STATOR FRAME FOR SHAWINIGAN UNIT — WEIGHT, 95,000 LB.—ON 35 FT. BORING MILL

ate shafts and coupled together on account of the enormous weights of these parts.

The main bearing is of the General Electric spring thrust type, consisting of a lower disc with a polished steel surface, split into sectors and supported on a great number of small helical springs on which rubs an upper, solid,

best current distribution among the conductors; although owing to the different reactance of the conductors in different positions, the reactance drop is not the same in all cables, yet the difference is not great enough to cause overheating of any one conductor.

Disconnecting switches are provided in the 11,000-volt cables to facilitate the making of tests.

There will be two 110,000-volt circuit breakers connecting the transformers to the high-tension bus, as it was considered inadvisable to depend on one switch for so large an amount of power. These breakers are each to be placed in a separate chamber which can be completely shut off so that the effect of a possible fire or explosion may be localized. Provision will be made to ventilate the switchrooms by small electrically driven exhausters, so as to prevent the accumulation of inflammable gas from the vaporizing of the switch oil.

GRAVEL AND STONE ROAD MAINTENANCE*

Difference Between Repair and Maintenance of Gravel Roads — Screening Equipment — Gravel Used in Elgin County — Shaping Roads in Spring

By F. Pincio,

Elgin County Road Superintendent.

ROAD maintenance consists of keeping it as nearly as practicable, in the same condition as it was when originally made; the repair of a road is the work rendered necessary to bring it up to its original condition after it has deteriorated by neglect. Thus there is a wide distinction between the two operations, and when the comparison of costs is made, errors are frequently caused by setting the repairs of one road against the maintenance of another or vice versa.

No matter how well made a structure may be, or how carefully the materials have been inspected, after being used it will exhibit defects which it is almost impossible to guard against, such as variability in the quality of the material and slighting on the part of the workmen. Moreover, every material, whether natural or artificial, is continually undergoing a process of deterioration by the action of the elements; this decay is hastened or retarded in proportion to the means employed and care bestowed to arrest it.

The crown of the road should be sufficient to allow water to pass freely to the ditches on the side of the roadway. On many of our gravel roads in Elgin county, the shoulders were higher than the centre of the road. These have been thrown outward and either spread uniformly along the sides or drawn to some narrow or dangerous point on the road. Where the shoulders of the road are high, it makes impracticable the use of the most necessary implement for the maintenance of a gravel or earth road, the split log drag. After the shoulders have been thrown outward, the grader is then reversed and if there is any good material, it may be drawn to the centre of the road. Great care should be taken that no sods or poor, worn materials are thrown into the centre of an old gravel road.

Roads Resurfaced with Screened Gravel

Resurfacing should be done with nothing but the best grade of screened gravel, well spread out free from earth or any stones that will not pass through 1½-in. ring. In Elgin we have 256 miles of county road, of this mileage about 190 miles is gravelled; 25 miles is either macadam or stone road, and the balance is clay or sand. We own five gravel pits, these are located in different parts of the county with the view of trying, as near as possible to furnish material for the entire county highways and not have the haul exceed more than ten or twelve miles.

Semi-portable bin, elevator and screen is used for re-

moving large stones and makes loading of trucks and teams quickly done, the bin holds 30 tons, the floor or bottom of the bin has a slope of about 50 degrees, so that the gravel will slide to the opening or shut on the side of the bin. The gravel screen is 9 ft. long, all in one piece with 3 ft. perforated with ¼-in. holes for sand, 3 ft. blank, to carry gravel across bin which is 12 ft. wide and 3 ft. of 1½-in. holes, in this manner the gravel becomes all mixed from a reasonable portion of sand to any stone that will not pass through a 1½-in. ring where the gravel drops into the bin. The elevator is the bucket type 32 ft. long with hopper at bottom, gravel is brought from the bank with the ordinary slush or slip scraper drawn by a horse and dumped into the hopper, the horse passing directly over the hopper which is protected by grizzly bars.

A regular gang of men are employed in this work during the working months in the year, they are furnished with portable cook house, sleeping tents, etc., this equipment takes care of the whole gang including the truck drivers. We handle from 125 to 160 tons of gravel per day.

Truck Loads

Teamsters usually haul about one and one half yards to the load and are instructed to make four dumps of this size load, spread it at least 10 ft. wide and in this manner one load of gravel will cover about 10 ft. of road, in length. The trucks are of the dump body type carrying a load of five yards, which load will cover about 200 ft. of road in length, 6 ft. wide, in some cases three widths of gravel are put in by the trucks making a spread 18 ft. wide.

In Elgin county gravel is the natural road building material. While this may not be the best type of road to construct I believe that we can build enough extra miles of fairly good road to travel on than they would if we were to expend our money on a more permanent road in a small mileage. The County of Elgin has no road roller, nor do I see any use for one as long as we continue our present method of constructing and maintaining gravel roads. A gravel road is very apt to break up during the early spring, but it is only a matter of a few days and if properly attended to at the right time, it will come back in its original shape, therefore emergency of this kind should be provided for by having storage gravel piled along side of the road which can be quickly put on if necessary.

Early Spring Best Time For Road Repairs

The writer has found that the early spring is the proper time to go over gravel roads and shape them for the coming summer. Where a gravel road is inclined to be wavy our method for levelling is to use the standard size grader, turn the blade crosswise of the road and plane the unevenness down in this way. This can be done in the early spring. If we find the roadbed too hard for the blade we remove it and attach a scarifier on the grader where the blade has been. After the roads have been shaped in this manner, the ordinary split-log drag will keep them in a fair condition for the balance of the summer, providing that enough shifting material of gravel is on the road which is quite necessary in order to maintain a gravel road. Gravel should never be placed on an old gravel road more than 2 in. in depth, never get too much gravel on the road in one place and let the traffic roll out the road instead of a road roller. A patrolman should be appointed about every two and a half miles, furnished with a split log drag or small grader.

Hon. F. C. Biggs, Minister of Public Works and Highways, stated recently that there is now 49,785 miles of metal surfaced roads in Ontario, 23,166 being gravel roads and 566 miles permanent highway. He promised that by the end of the present year the foundation would be laid for a permanent highway from Windsor to the Quebec boundary.

*Paper read at the 125th Annual Conference on Road Construction, Toronto, Feb. 27-28.

EFFECT OF SPEED ON HIGHWAYS*

Road Surface Effected By Speed — Impact on Pavements —
Tractive Resistance of Various Pavements — Variation
Of Speed Limit in Different Provinces

By W. G. Robertson,

Secretary-Treasurer of the Ontario Motor League.

IT HAS been estimated from available statistics that the volume of road-borne traffic in Canada is ten times that of the rail-borne traffic. There is no need to discuss the relative importance of the railway and the highway, both are essential, each being the complement of the other, but as speed is admittedly a prime factor in railway operation, it is worth while to consider this factor in relation to the highways which carry the great bulk of the traffic.

Speed, for the purpose of this discussion, will be taken in the sense, rate of travel or velocity rather than in the sense, to make haste, perhaps unnecessarily. Let me say here that so far as "speeding" or exceeding the speed limit is concerned, the Ontario Motor League, which organization I have the honor to represent, stands for the same observance of the law and advocates a reasonable regard on the part of all motorists for the rights of others using the highways. Safe driving and courtesy under all circumstances are expected by the League of all its members.

There are many angles from which the question of speed of motor vehicles may be considered. It might be taken up from the standpoint of engine efficiency and fuel economy; from the standpoint of tire efficiency and economy; from the standpoint of experience and skill on the part of the driver; with regard to the factor of safety, or with regard to the effect of speed on road surfaces. Each of these various aspects of speed is worthy of serious thought and capable of considerable elaboration, but it will be necessary for the present to confine our attention largely in the aspect in which the Good Roads Association is chiefly interested, the effect of speed on road surfaces.

It is well known that speed is a very important factor in the amount of destruction which results from the unrestricted use of the roads by vehicles. The impact increases very rapidly with increase of speed. It increases much more rapidly in the case of a truck equipped with solid tires than one equipped with pneumatic tires, because of the greater resilient qualities of pneumatic tires.

A report issued by the United States Bureau of Public Roads on the "Effect of Impact on Pavements" gives some interesting information on this subject, and shows that the impact resistance increases with the velocity, with the total weight of the vehicle, and with increasing road-surface roughness. In these tests, the impact resistance of good asphalt or bitulithic or other smooth pavement, was practically negligible, and reached its highest values on granite-block roads with sand filled joints, and on badly worn macadam pavements. The rate of increase of impact resistance with speed was most marked on the roughest roads.

Tractive Resistance

The following urban pavements are enumerated in the order of their desirability for vehicle operation from the point of view of tractive resistance at 20 km. (12.4 miles) per hour, as found in this investigation. (1) asphalt, (2) wood block, (3) hard smooth macadam, (4) brick block, (5) granite block with cement-filled joints, (6) cinder, (7) gravel, (8) granite block with sand-filled joints.

The equivalent grade at 120 km. (12.4 miles) per hour of a badly worn city macadam road, was found to be nearly three times as great as that of the best asphalt road tested. This means, at this speed, a consumption of energy at wheel treads, of nearly three times as much on level macadam roads as on good level asphalt roads.

Increasing the gross weight of the vehicle by 12 per cent. through load, was found to have no effect on tractive resistance within the observed speed limits for smooth roads in good condition, but on rough roads, a distinct increase in tractive resistance with this extra weight was observed.

Effect of Speed on Road Surface

Tests have been made which show that increased speed of a vehicle equipped with hard rubber tires tremendously increases the impact which its wheels make on the roadway where there is any unevenness. On the other hand, where pneumatic tires are used, increased speed adds comparatively little to the impact. It has been suggested that these tests will be of great value not only in settling questions of design, but may also lead to a rational basis for determining license fees for motor vehicles.

Trucks have been used in these tests varying in size from a 1-ton up to a 7½-ton truck carrying an excess load. Each truck was run over a special recording device imbedded in the roadway and the impact which resulted, when one of the wheels made a two-inch drop from a ledge built in the surface, was recorded.

Recent tests were made with a 3-ton truck loaded so that the weight on each rear wheel was 7,000 lbs., the unsprung portion being 1,700 lbs. and the sprung portion 5,300 lbs. The truck was equipped first with an old solid tire that was worn down to a thickness of one inch. Then, with exactly the same load on the truck, a wheel was fitted with a new solid tire 2½ inches in thickness. And finally, the truck was equipped with pneumatic tires 42 by 9 in., blown up to a pressure of 142 lb. per sq. in. The following table shows very clearly the bad effect an old tire is likely to have on a road surface and the greatly lessened impact which is produced by trucks equipped with pneumatic tires. The tests show that as the vehicle's speed was increased, the impact from the old hard rubber tire increased greatly. The impact from the new tire was somewhat less.

Speed M.P.H.	Old Tire Lbs.	New Tire Lbs.	Pneumatic Tire Lbs.
5.7	11,600	9,400	7,000
10.2	18,500	14,100	7,900
14.6	26,500	18,700	8,330

In fixing speed limits for motor vehicles, Legislators hitherto have given consideration mainly to the question of safety. Diversity of opinion as to what constitutes a safe maximum speed is reflected in the variety of legislation on this subject in different provinces and states. The State of Kansas sets 40 miles per hour as the upper limit of speed in the open country. California and a number of other states draw the line at 35 miles per hour, while 30 miles per hour is about the average for all the states.

Speed Limits

Thirty miles per hour is the maximum speed limit in British Columbia, while the other Western Provinces fix no limit other than requiring speed at all times to be reasonable, having regard to traffic. In Ontario, Quebec and Nova Scotia, the upper limit has been fixed at 25 miles per hour. New Brunswick sets no definite speed limit other than what is reasonable, having regard to traffic, while Prince Edward Island, but recently opened up to the automobile, puts the ban on a speed in excess of 15 miles per hour.

In Ontario, the Load of Vehicles Act (Section 5) stipulates that no vehicle carrying a weight in excess of four tons, including the vehicle, shall be operated on any highway at a speed greater than ten miles an hour; and no vehicle carrying a weight in excess of six tons, including the vehicle, shall be operated upon any highway at a speed greater than eight miles an hour.

The speed limits for trucks provided in the Ontario Act are extremely restrictive. If modified in conformity with recent experience, all commercial vehicles equipped all around with pneumatic tires would be restricted to 25 miles per hour on open country highways, while commer-

*Paper read at the Annual Convention of the Ontario Good Roads Association, Toronto, March 2.

cial vehicles equipped partially or all around with solid tires, would be required to conform to the following speed schedules:

Gross Weight	Open Country
Under 2 tons	Highways
2 to 6 tons	25 miles per hr.
6 to 10 tons	20 miles per hr.
10 to 14 tons	15 miles per hr.
	12 miles per hr.

To fix the speed limit of commercial vehicles at an extremely low figure, means also interference with the free movement of general traffic on the highways. On a road of average width, when there is a steady stream of traffic in opposite directions, it is at once both difficult and dangerous to pass a succession of slow-moving vehicles, in the face of oncoming traffic. The great increase in motor traffic indeed points to an early necessity of providing such width on main highways as will enable trucks and slow-moving vehicles to travel the outside of the road, and leave a lane of sufficient width for two lines of the more swiftly moving passenger cars. Under present conditions it is just a question whether it might not be conducive to safety to require all motor vehicles to travel at not less than a minimum rate of say twelve miles an hour under normal traffic conditions.

Factors Affecting Speed of Vehicles

Width of highways, degrees of grades and curves, nature of road intersections, ditches, and railway crossings, and volume and kind of traffic, are all factors which must be considered in determining speed from the standpoint of safety. So complex are these factors that it is impossible to state what might be considered a reasonable speed on any but a straight-away stretch of country road, without taking into account local conditions. Vigilance and sound judgment are essential to safe driving everywhere and no arbitrary speed limits can be devised which will relieve the drivers of motor vehicles from the ever-present obligation of giving due regard to constantly changing traffic and road conditions.

ONTARIO GOOD ROADS ASSOCIATION

TOWNSHIP, county, town and city officials from all parts of Ontario met at the Ontario Veterinary College, Toronto, on March 1, 2 and 3 for the twentieth annual meeting of the Ontario Good Roads Association.

T. J. Mahony, of Hamilton, president of the association, occupied the chair throughout the sessions. At the first session, on Wednesday morning, nominating and resolutions committees were elected. The report of the executive committee was received and various questions and resolutions were submitted by the delegates.

On Wednesday afternoon, addresses were delivered by Hon. F. C. Biggs, minister of public works for Ontario; Hon. Harry Cockshutt, lieutenant-governor of Ontario; Prevost Hubbard, chemical engineer of the Asphalt Association, New York City, and T. J. Mahony, president of the Ontario Good Roads Association.

W. G. Robertson, secretary of the Ontario Motor League, opened the Thursday morning session with a paper on "Speed on Highways." Mr. Robertson was followed by Controller Russell Nesbitt, of Toronto, who welcomed the delegates to the city and assured them that Toronto realizes what good roads mean to her citizens. G. C. Parker, of the Ontario Department of Public Highways, read a paper on "Headlights." G. F. Pineo, road superintendent of Elgin County, spoke on "Highway Accounting"; and F. H. Richardson, warden of Ontario County, delivered an address entitled "Provincial Highways, How Should They be Paid For?" Mr. Richardson discussed the justification for direct taxation and the question of whether there should be a provincial equalization of assessment.

W. A. McLean, deputy minister of highways for Ontario; Hon. J. L. Perron, minister of highways for Quebec; K. W. McKay, clerk of Elgin County; E. A. James, chief

engineer of the Toronto and York Roads Commission; and D. J. Kean, superintendent of highways for Ontario, also delivered addresses at the session on Thursday afternoon, and at 7:00 p.m. the annual banquet of the association was held in the Pompeian Room of the King Edward Hotel.

At the last session of the convention, which was held on Friday morning, there was a round-table discussion on township roads, lead by the following superintendents:

Silas Toole, Pickering Township; Peter Upcott, South Gosfield Township; James Todd, Yarmouth Township; J. D. Flanders, Dereham Township; Walton Smith, Nepean Township; James Hunter, Nelson Township; and Wm. E. Hambly, Townsend Township. Among the topics discussed were maintenance, construction, highway accounting, and the abolition and commutation of statute labor.

After the presentation of the reports of the committee on resolutions and of the nominating committee, the following officers were elected for the ensuing year:

Honorary presidents, Capt. Lucius E. Allen, Belleville, and T. J. Mahony of Hamilton; president, W. H. Brown of Bruce; first vice-president, John Currie, Middlesex; second vice-president, Geo. S. Henry, York Township. Directors—J. E. Jamieson, Simcoe; F. A. Senecal, Prescott; W. H. Nugent, Hastings; Alvin Rose, Brant County; P. Ray, Wentworth County; and Fred Richardson, Ontario County.

ONTARIO'S COUNTY ROAD SUPERINTENDENTS HELD EIGHTH ANNUAL CONFERENCE.

UNDER the auspices of the Ontario Department of Public Highways, the county road superintendents of that province held their eighth annual conference on road construction at the Parliament Buildings, Toronto, on February 27 and 28.

Hon. F. C. Biggs, minister of public works and highways for Ontario, welcomed the members of his staff and emphasized the importance of county and township roads, as distinct from the provincial system. He called special attention to the need for adequate drainage, for permanent roads of the highest types, and for the maintenance of gravel and other temporary roads.

W. A. McLean, the chairman, expressed pride in the work of the highway engineers of Ontario and in the system of roads that is being obtained as a result of their efforts. The subject for the first session, "Concrete Bridges and Culverts," was well covered in a paper by W. J. Moore, of Renfrew, the discussion being introduced by John Young, of Wellington, and D. J. Kean, of Ontario County.

Tuesday morning's session commenced with a paper on "Concrete Road Surfaces," by L. A. Pardo, of Kent County, followed by a short introductory talk on the subject by L. S. Litche, of Waterloo. Frank Pineo, of Elgin County, read a paper on "Gravel and Stone Road Maintenance." The discussion was introduced by R. H. Fair, of Frontenac, and S. Fox, of Hastings.

"Bituminous Road Surfaces" was the subject of a paper presented by Alan K. Hay, of Ottawa, at the concluding session, on Tuesday afternoon. G. Marston, of Norfolk, and Wm. Waters, of Lanark, opened the discussion. Frank N. Rutherford, of Lincoln, delivered a paper on "The Early Preparation of County Road Programs." The discussion being opened by E. L. Miles, of Victoria, and N. L. Powell, of Peel County.

Following his assurance to the House that preliminary steps would be taken to look into the matter of Chippawa costs, Premier Brury, it is understood, is calling into consultation the firm of Stewart and Kerbaugh, the well-known American consulting engineers. The firm of Stewart and Kerbaugh was one of those engaged by the Hydro-Electric Commission to report upon the Chippawa work, and the estimate of \$55,000,000 given to the House last session, and which has now been exceeded, was to a large extent, the estimate of that firm.

HIGHWAY DRAINAGE AND THE APPLICATION OF DRAINAGE ACTS*

Sub-Base Drainage Problems—Procedure Followed in Carrying Out Drainage Schemes Under Ditches and Watercourses and Municipal Drainage Acts

By U. W. Christie,

Dufferin County Engineer.

DRAINAGE besides carrying off the surface water from the road reduces the water content of the sub-grade and improves the foundation. Road failures have largely been the result of weak foundations at the time frost is coming out of the ground, when the water content of the soil is high and foundations are consequently weakened. If we except the Telford and probably some other large stone and sub-base types of road, foundations have not been built with large enough interstices to resist capillarity. Hence the water level must be lowered an amount to overcome capillary action, just how much depends upon the character of the subsoil. In light soils the water rises rapidly and falls rapidly, in heavy soils it rises more slowly and falls more slowly. In light soils the percent of water in the soil decreases rapidly with the height above the source, while in some heavy soils the water content is strikingly uniform at different depths.

Horizontal capillarity occurs with much faster water movement and greater uniformity of moisture content. The speed and distance vary with the different soils and ranges from 7 to 33 ft. in the first 24 hours. The rapidity with which capillary action occurs when there is a free source of water makes it necessary to remove this source with the greatest promptness if a substantial road foundation is to be maintained.

Height of Sub-grade Above Water Surface

If it is absolutely necessary to allow water to stand or flow along a road for even a few hours, the height of the sub-grade above the surface of the water and its distance horizontally from the water source must be considered.

For water on the side of a road for one day at a time, we would require a height of subgrade of about 18 in. and if the horizontal distance was large we might reduce this; but if the road were alongside a pond or lake or any body of water that remained for a considerable time, the height of subgrade above the surface of the water would have to be increased to a height of 3 or 4 ft.

In grading the practice has been to excavate from the sides of the road to raise and form the grade, if these trenches have not a continual fall to outlets where water will run freely away, they are not drains but elongated ponds which hold the water and permit it to soak into and soften the roadway. Water must be made to flow from the road as quickly as possible. Trenches should not be carried along the side of the road and past outlets as has frequently been done. Water should be discharged in small quantities into frequent outlets. Culverts should be so placed that water carried across the road will be carried off the road directly from the culvert.

Use of Tile Drains

Tile drains should be made use of to carry water away from all springy or soft spots in the foundation and to intercept water likely to reach the foundation. A tile drain should always be placed on the higher side of a side hill road, if there are indications of water trouble and often on the face of a hill, in the latter case the drain may be in the centre or to one side of the road. Tile drains should be about 3 ft. deep, should be laid carefully to grade and should be covered with an open material such as gravel, crushed stone or cinders, if in quicksand the tile should be laid on boards and cinders should be used in preference to gravel or stone.

Where a tile drain is required to carry off surface water, it should be at least 6 in. in diameter and for this purpose ordinary porous field tile are not suitable, the tile should be concrete or vitrified pipe with bell and spigot ends or some other approved form of joint and each pipe should have a laying length of 2 ft. The surface water should enter through catchbasins, the floor of which should be 2 ft. below the invert of pipe. A cheap way of building these is to place 24 in. diameter pipes in vertical column and place 4 in. of concrete in the bottom and a cast grid on top. Catchbasins should be cleaned out frequently to insure the tiles remaining open.

Obstructions that will impede the free flow of water should be removed from culverts and drains at frequent intervals and a special effort should be made each fall to see that this is done and also to see that fences are removed from all drains.

In most county road drainage problems, other roads and lands are affected and the machinery for initiating, carrying out and distributing the cost of these is provided for in our Ontario Drainage Acts of which there are two, the Ditches and Watercourses Act and the Municipal Drainage Act. The former is for the smaller undertakings and for forcing an outlet, and the latter for the larger undertakings.

Work that may be undertaken under the Ditches and Watercourses Act is limited to a cost of \$1500 and to a length of 7 township lots. The land, the owners of which may be made liable for the construction, is that lying within 150 rods of the sides and upper end of the drain.

The owner of higher lands has not the right to construct the drain to dump water on lower lands and if such a drain be constructed the owner of such lower lying lands may block up or dam such a drain. In fact the owner of the low lying lands may block back a surface flow of water, but not a natural watercourse. Drainage may only be undertaken by agreement of owners or by the legal application of the drainage laws.

Ditches and Watercourses Act

A party requiring an outlet and wishing to proceed under the Ditches and Watercourses Act would proceed as follows: He would file with the clerk a declaration of ownership, and would obtain from him a form of "Notice to Owners of Land Affected by the Proposed Ditch" and also a form of "Agreement of Owners." The notice of owners he would fill out sign and serve personally, or leave with a grown up person at the usual place of abode of the owner or occupant; in the case of a non-resident he would serve the notice upon the agent of the owner or send by registered post to the post office nearest the place of his last known residence, and where his place of residence is not known, then notice may be served as directed by the Judge. The notice should name a day and hour and also a place convenient to the proposed ditch at which the owners are to meet and if possible come to an agreement as to the apportionment of the work and supply of material for construction. The time between the serving of the notice and the calling of the meeting shall be at least two clear days, the day of serving and the day of the meeting do not count. Parties notified have 5 clear days after service to apply to the county judge to set aside proceedings on the ground that the person commencing proceedings is not an owner within the meaning of the Act. If no such application is made or is made and is not successful, the ownership is thereafter not open to question.

If an agreement is arrived at, it shall be reduced to writing and filed with the clerk within six days after the signing thereof. Should two or more municipalities be affected the agreement shall be in duplicate or triplicate, etc., and one copy shall be filed with the clerk of each municipality.

Should it happen at the meeting of owners that notices were omitted or improperly served the owners present may adjourn the meeting to a subsequent date to allow the notices to be properly served.

*Paper read at the Eighth Annual Conference on Road Construction, Toronto, Feb. 27-28.

The head of council of any municipality may sign the agreement as owner. If an agreement is not arrived at by the owners at the meeting or within five days thereafter, the owner requiring the ditch may file with the clerk of the municipality a requisition, naming therein all the lands that will be affected and the respective owners thereof requesting the engineer to appoint a time and place at which he will attend to examine the premises, parties and their witnesses, if any.

The clerk shall notify the engineer, who will in turn notify the clerk of the time and place at which he will attend. The clerk files the copy of the appointment of attendance of engineer and sends one copy by registered mail to the party making the requisition, who shall, at least four clear days before the time appointed serve notice upon the other owners requiring their attendance. After the service of these notices the party shall indorse on one copy the time and manner of service and leave with the engineer at least the day before the date fixed in the notice of appointment.

The engineer will attend at the time and place, examine the premises and if he considers a ditch necessary will lay it out. In due time he will file his award with the clerk, who shall notify each of the persons affected within the municipality by registered letter or personal service, of the part of work to be done and material to be furnished by each person.

Any owner affected by the award may within 15 days of the notice of the filing of the award appeal therefrom to the judge. The appellant shall serve upon the clerk of the initiating municipality a notice in writing of his intention to appeal, shortly setting forth the grounds for appeal. The clerk will notify the judge of the appeals and will furnish him with a copy of the award. The judge will fix a time and place to hear the appeal at which he may set aside, amend or affirm the award. The order of the judge shall be filed with the clerk and the award as altered or affirmed, may be enforced in the same manner as the award of the engineer.

If the drain be not completed at the time specified in the award, the engineer may let the work and the supply of material to the lowest bidder and the cost shall be borne by the parties failing to comply with the award.

The drain shall be maintained by the parties whose lands have been awarded maintenance, and any owner who fails to do so may be notified in writing by any other owner party to the award to have his portion put in repair within 30 days from the receipt of such notice; and if the repairs are not made and completed within such 30 days, the owner giving the notice may notify the engineer in writing, to inspect the portion complained of. The costs of enforcing maintenance are collected in the same way as costs of construction.

Municipal Drainage Act

Under the Municipal Drainage Act, new work must be undertaken by a petition, which must be signed by a majority in number of the resident and non-resident persons exclusive of farmers' sons and others not actual owners, as shown by the last revised assessment roll to be the owners of the lands to be benefited in any area described in such petition within any township, incorporated village, town, or city, to the municipal council thereof, for the drainage of the area described in the petition.

The council procures an engineer or Ontario land surveyor to make a report which would include an estimate and recommend an assessment on the owners of lands and roads. Upon the filing of the engineer's report with the clerk of the municipality, the clerk shall by letter or postal card to notify the parties assessed of such assessment and the amount thereof, and the date of the council meeting at which the report will be considered. The engineer's report shall be of as many copies as there are municipalities affected and the initiating municipality shall notify each other municipality.

At a meeting for considering the report the clerk shall read the report to all the ratepayers in attendance and an opportunity shall be given to any person who has signed the petition to withdraw in writing and an opportunity shall be given to persons who have not signed the petition, to do so. Should the petition at the close of the meeting contain the names of the majority of owners, the council may proceed to adopt the report and pass a by-law authorizing the work, but if after striking out the names of the persons withdrawing, the names remaining including those added do not represent the majority of owners according to section 3 of the Act, then the persons who have withdrawn from the petition shall on their respective assessment on the report, with 100% added thereto, together with the other original petitioners, be pro ratio liable to the municipality for all expenses incurred.

For repairing drains constructed under the Act it is not necessary to have a petition, a simple resolution of council is all that is required and any one having a grievance owing to the non repair of a drain simply makes application to his council, whose duty it is to have repairs made.

In the case of reports by an engineer for a new drain or for the repairs of an old drain under Sections of the Act, where the assessments are varied from their original proportions, there are appeals.

- (1) By individuals.
 - (a) To the Court of Revision.
 - (b) To the County Judge.
 - (c) In certain cases to the drainage referee.
- (2) By municipalities in case of two or more municipalities being affected.
 - (a) To the drainage referee.
 - (b) To the High Court.

REPORT OF SASKATCHEWAN HIGHWAYS

A REPORT of the Department of Highways of Saskatchewan has been issued covering the work of the department for the season of 1921. The following information has been taken from the report. The department assists rural municipalities in the construction and maintenance of main roads, the work being done either by the municipality under departmental supervision or by the department, the expenditures being charged to capital account. The department also carries out similar work in unorganized districts. During 1921 the department entered into 959 contracts with rural municipalities, the expenditure being \$538,000, and in addition carried on 476 separate pieces of road work costing \$357,000. The department also assists rural road maintenance by grants to each of the 300 rural municipalities, the grants varying according to area but averaging \$500. Under this head the 1921 expenditures were \$145,000. For road construction on the provincial main road system under the Canada Highways Act the year's expenditure will be \$534,000, of which the federal government pays forty per cent.

The mileage was, Under contract, 225 miles of earth road, costing \$320,000; by day labor: 95 miles of earth and gravel road, costing \$214,000. Preliminary surveys for future work under the Canada Highways Act have been completed for 1,075 miles. On the construction or repair of 140 timber bridges the expenditure will be \$153,000, while 12 permanent bridges have been built at a total cost of \$155,000, and seven steel trusses erected at a cost of \$48,000. Other sundry expenditures are: Road drag competition and high posts, \$20,000; ferries, \$115,000; fireguards, \$1,000; water supply, \$15,000; surveys, \$47,000; drainage works, \$30,000, a total of \$228,000 for sundries.

The uniform wage schedule adopted by the Western Builders' Convention held at Calgary has been endorsed by resolution of the Association of Building and Construction Industries of Moose Jaw.

STONE ROADS MAINTENANCE*

Advocates Water-Bound Roads — Gang System for Repairing Gives Better Results Than Patrols — Maintenance Work for Three Seasons

By E. A. James,

Chief Engineer, Toronto & York Roads Commission.

DURING the last two years the type of construction on our main roads has so improved that we have heard little or nothing of stone roads, but there are many miles of stone roads to be built which, if properly constructed and maintained, will give excellent service.

While agreeing that for heavy traffic on a few of our main thoroughfares, concrete or a concrete base with a bituminous top is the only economical form of construction, yet the writer is just as thoroughly convinced that this type of construction on lesser travelled roads is at present a waste of both energy and money.

Stone roads may be divided into two classes.

- (a) Stone roads bound by traffic;
- (b) Stone roads water bound.

While the writer does not advocate the construction of roads of the former type, yet we find that many miles are still being built, and with a medium hard stone and iron tired traffic, it is surprising how quickly they bind and re-bind. Their maintenance, however, must necessarily be somewhat haphazard, as one cannot estimate just how they will act under traffic. Holes should be filled with 1-in. stone, sprinkled with limestone dust or loam. The sides of the road should be kept well shaped so that water will run quickly to the ditches. Oiling may be adopted similarly, and similar methods to those used on water bound macadam. We are, however, dismissing the maintenance of this type of road with a few words. Firstly, because this type is not economical either in construction or maintenance, and secondly because the remarks on the maintenance of the second type may be applied, with slight modification, to the maintenance of roads of the first type.

Patrol and Gang Systems

In maintaining roads, two types of organization have been adopted, namely "patrol" and "gang." Both systems have merit, but in our experience the gang system has given better results.

In the patrol system, one man or at most two men, have a small mileage to look after, and we have found it very difficult to secure a man who is a good workman and of the temperament that makes it possible for him to work steadily day after day alone, patching and cleaning up along the roadside. Although he works conscientiously, we find that without someone with whom he can compete he becomes slower and slower, until although he is busy all day he only does from one-half to three-quarters of the work a man should do.

By adopting the gang system, we find that by using very light motor trucks we can give a foreman twenty to twenty-five miles of road, and from four to five men. Under this system we can secure foremen of greater ability and with more initiative, and there is companionship and rivalry among a man and his gang and between gangs, which tends both for efficiency and economy.

On stone roads well built, there are several months in a year when little or no maintenance is necessary and the gang can be used to construct small culverts, do light grading or build short stretches of improved road. In this way the foreman and his men maintain their interest in road work, and we have found that the men who have had experience in road building are, without exception, the best men to employ on road maintenance.

The advocates of hard surface roads make the statement that the maintenance of a stone road commences the day after it is built, and while this statement is true and should be emphasized, yet it does not deter us from building stone roads.

First Season Maintenance

The maintenance for the first few weeks after a stone road has been completed, consists of seeing that the limestone film is worn uniformly without removing the filler between the stones. In other words, endeavor to get the traffic to distribute itself over the full width of the pavement. With the first indications of travelling, oiling should be commenced. This first oiling consists of spraying with a light asphaltic oil, say 40% bitumen, applying approximately one-third of a gallon per square yard, and then sanding the applied oil. During the first season only light oils should be used on stone roads, otherwise there is danger in forming cakes on top of the limestone film, which break and cause the road to pit. Such a stone road, oiled in this manner, will take legal traffic up to 75 motor cars and 100 horse-drawn vehicles per hour. The second step in this maintenance will occur the following spring, when a few holes may develop, due to the unequal rolling or stones of unequal size being used. These holes should be cleaned out, the loose stone removed, and the hole patched with 1½-in. stone, bound in place by bitumen poured hot, using approximately 14 gallons of bitumen per cubic yard of stone. It is well not to use too much bitumen, nor to fill the hole too full, otherwise there is a tendency to shove. The patch should be pounded with a hand pounder. The second method of patching is to use K.P., which is a bitumen that may be mixed with the stone cold, and the mixture thus formed tamped into the hole that has been properly cleaned and shaped. In this case it is better to use a mixture of ½-in. and ¾-in. stone, thus producing a dense aggregate.

Maintenance During Second Year

During the second year, it will always be found a good investment to treat with bitumen the water bound macadam road, and whether it is done before or after the patching is immaterial. It will usually be found, however, that to get the best from carpet surfacing the road should be treated early in the season, before there is time for patching, but this does not spoil the patch work, as the bitumen penetrating the road assists in binding in the patches, whereas if great care is not used in spraying, bitumen applied on top of the patches cuts back the binder in the patches causing them to shove. The second year treatment should be preceded by careful sweeping to see that all dust, dirt and film has been removed. This may be done with the aid of hand brooms, or by using horse-drawn revolving brooms. Care must be taken, however, not to sweep so vigorously as to disturb the stone.

The weight of the carpet coat for the second year will depend upon the character and intensity of the traffic, but a tar having the consistency of Tarvia "B" or a 65% asphalt sprayed evenly and hot; 1/3 of a gallon to the yard and 30 lb. of ½-in. chips or pea gravel per square yard, will mat into a wearing surface that will carry the traffic of our leading highways, 400 motor cars and 75 horse-drawn vehicles per hour. In the fall the necessary patch work should again be carried out, when it will be found that the carpet coat has ironed out into a perfect mat.

Third Season's Work

The third season, patching in the Spring as before will be required, but the carpet coat can be reduced to 1/6 of a gallon of bitumen per sq. yd., and the stone to 10 lb. per sq. yd.

Thin repairs may be made by spraying from a watering can hot bitumen, and sprinkling with ½-in. chips or pea gravel. Where the road is covered with a mat of bitumen, this surface patching is very advantageous, as it prevents holes developing.

*Paper read at the Ontario Good Roads Association meeting, Toronto, March 2.

REPORT OF COMMITTEE ON TOWN PLANNING

Report Presented at Association of Ontario Land Surveyors' Meeting, Toronto, Feb. 21-23

By Horace L. Seymour, O.L.S.

Chairman of Town Planning Committee

FOR several years papers and reports relating to town planning have been presented at the annual meeting of the Association. In this work T. D. LeMay, city surveyor, Toronto, has been the pioneer. His broad definition of town planning is "a willingness to do one's duty towards one's neighbor." If we accept this definition every citizen should be a town planner in the widest sense of the term.

Town planning deals not only with material things but with human and social relationship. In the narrower sense of the term, the surveyor has a function to perform in town planning in a technical way. To be successful, however, he must have the broad outlook which Mr. LeMay embodies in his definition of town planning.

The report of your Committee on Town Planning this year consists of short reports from the members of the Town Planning Committee on town planning activities in various sections in Ontario. As proposed, the programme was as follows: Northern Ontario, G. M. Summers, Hailbury; Southwestern Ontario, J. J. Mackay, Hamilton and F. N. Rutherford, St. Catharines; Toronto and vicinity, T. D. LeMay, A. J. Van Nostrand and N. D. Wilson, Toronto; Eastern Ontario and general, Horace L. Seymour, Toronto.

Northern Ontario

We were very fortunate in hearing from H. T. Routly, on "The Development of Townsites in New Ontario." In the past I believe there are some surveyors who have looked on town planning as something of a fad or as something of a luxury. Mr. Routly has shown it to be a matter of stern necessity in the development of the North country. He states that this is not only an opportunity for the town planner but that it is a call of duty to the town planner and we want surveyors to be town planners, or at least to be sympathetic to town planning principles.

In the western provinces, and I am familiar especially with the provinces of Alberta and Saskatchewan, all proposed subdivisions must be approved by the Government and are subject to inspection on the ground. In Saskatchewan, I understand, every proposed subdivision is visited by an inspector. W. A. Begg, surveyor, is town planning director for the province of Saskatchewan. Recently, W. E. Hobbs, surveyor, has been appointed town planning controller under the 1916 Manitoba Town Planning Act, and will approve of all subdivisions. Surely the province of Ontario should delegate to the proper officials full powers in the approval of subdivisions, wherever located and should offer every facility for that approval.

A report covering South Western Ontario was presented by J. J. Mackay, of Hamilton, and another covering Toronto and vicinity was submitted by A. J. VanNostrand and N. D. Wilson. This was followed by an interesting lantern talk on "Maps and Plans of Toronto," by T. D. LeMay.

Eastern Ontario and General

Last year the attention of the members was directed to the assistance of the Town Planning Institute of Canada. There were seventy-five Ontario members. There are eighteen architects, while the engineers and surveyors together total fifty-one, twenty-five engineers and twenty-six surveyors, although some of the latter are now mainly or entirely engaged in engineering. The Toronto Branch although claiming but few regular members, has been doing good work, I believe. A. V. Hall, who spoke on the work at Knapuskasing, is a landscape architect and is chairman of the Toronto Branch. I am glad to tell you that surveyors generally form fifty percent of the attendance at the meeting.

There was held at Toronto recently a two-weeks course in town planning. This was attended almost entirely by others than the ordinary student. There were 48 enrolled—architects 14, engineers 20 and surveyors only 2. All those attending the course seem to have been very much pleased. If continued next year, I hope more surveyors will be present.

The Ontario Town Planning and Housing Conference recently sent a delegation to wait on the Premier. Premier Drury's attention was drawn to the fact that town planning legislation was scattered through various Acts and that in consequence the average municipality did not know its powers. The Premier promised consideration in the consolidation or codification of town planning powers. Town planning activities in Eastern Ontario, as far as I know, have been greatest in Ottawa and Oshawa, two municipalities that have active town planning committees. This is generally true, I think, throughout the province. I might mention the cities of Hamilton, St. Catharines, Kitchener, Waterloo, Guelph, Brantford, Niagara Falls and the Essex Border Utilities Commission.

REPORT OF COMMITTEE ON ENGINEERING, ROADS AND PAVEMENTS

Report Submitted to Association of Ontario Land Surveyors at Meeting in Toronto, Feb. 21-23

By J. M. Empey, O.L.S.

THE PAST year has been a most successful one in regard to the amount and quality of road construction accomplished in the Province of Ontario, by the different systems in operation under the supervision of the Department of Public Highways.

Early in the year many contracts for construction of permanent concrete culverts, bridges and pavements as well as grading of several hundred miles of road bed were entered into by the Department on its 1800 miles system of provincial highways. Similar conditions prevailed in the different counties in connection with county road systems, which received careful inspection and helpful assistance from the Department. The vast improvements resulting from this work had a good influence on all work undertaken by the townships, resulting in better work being done and of a more permanent nature. Greater care is being exercised to remove dangerous turns, narrow places and bad grades, all of which greatly increases the safety as well as the comfort of the travelling public.

Around larger centres like Toronto, Hamilton, London, Ottawa, St. Catharines and Brantford, considerable work has been undertaken and a goodly percentage completed. Programmes have been laid out for further extension in 1922.

Total mileage of roads in Ontario, all types, 23,166 miles.

	Miles
Gravel surface	23166
Stoned surface	3385
Bituminous surface	226
Bituminous Macadam	139 1/2
Asphaltic concrete	43
Concrete	118
Brick	1 1/2

Total mileages in provincial county provincial and county roads, 11,487 miles of which 9,400 miles are surfaced with the following types:

	Miles
Gravel surface	6728
Stoned surface	2161
Bituminous surface	221
Bituminous Macadam	140
Asphaltic concrete	42.7
Concrete	112.5

During the past year the Chippawa Power Canal, one of the greatest engineering works of the world has been

carried forward to a stage which enables them to utilize part of the plant to develop power for distribution. We feel justly proud of this vast undertaking, as it has been devised and developed entirely by our own Canadian engineers.

Considerable progress has also been made in preliminary work on the St. Lawrence deep waterways and power scheme. Considerable progress has also been made with preliminary survey and plans in connection with the International bridge over the Detroit River at Windsor, under one of our Canadian engineers.

Letters to the Editor

JANUARY INDEX NUMBERS

Sir: The price chart which we recently sent you, and which was published in your issue of February 21, was the result of studies made by the Presidents' Conference Committee of the railroads. The credit due this committee was inadvertently omitted from the chart.

The following index numbers for January, based on 1914 as 100, may be of interest:

Average, all commodities, 148; farm products, 116; food, etc., 134; cloth and clothing, 183; fuel and lighting, 183; metals and metal products, 117; building materials, 202; chemicals and drugs, 159; house-furnishing goods, 214; miscellaneous, 146.

L. H. BEAN,

Vice-president, Dwight P. Robinson & Co.

New York City, March 2, 1922.

ARCHITECTS AND FOREIGN MATERIALS

Sir: At the present time when every manufacturing industry in the country is making superhuman efforts to get business and consequently give employment to Canadian workmen, it behoves every architect and engineer who is truly Canadian to employ Canadian products in preparing their specifications.

The following extract is from a recent issue of the "Montreal Herald," and is worthy of publication in your magazine:

"A peculiarly heavy obligation rests upon architects who prepare specifications for materials and equipment.

"In some cases United States architects are employed, and these are in the habit of specifying United States goods, because they are not acquainted with the products of this country. Even in the case of architects of Canadian birth, many have had their training in the United States, and frequently, through lack of information relative to Canadian goods or lack of experience with Canadian products, they call for materials or supplies of United States production."

"In some instances, public bodies which are anxious to support the Made-in-Canada campaign to the fullest possible extent, have allowed specifications to be issued in which imported articles are called for, by direct mention of the name of manufacturers abroad, with or without some qualifying clause permitting the use of some 'equal' alternative. In this way the use of the imported commodities is impressed upon the mind of the contractor and he must take the full responsibility if any objections, justified or unjustified, are made to any alternative goods which he may substitute. Recently the school board of two large Canadian cities issued specifications calling for foreign-made master clocks and signal gongs as equipment for collegiate institutes. These specifications apparently were drawn up by their architects thoughtlessly or in ignorance of the fact that similar equipment, at least equal in quality to, and comparing favorably in price with, the imported equipment, was made by Canadian workers, in plants in

Canada which buy Canadian material and pay taxes in the Dominion."

"There is a duty also upon public bodies, private companies and individuals throughout Canada, to insist that the architects who prepare specifications for them, should call for Canadian products to the fullest extent consistent with the obtaining of satisfactory results at favorable prices. Responsibility also rests upon Canadian manufacturers and other producers to keep architects acquainted with their products by distribution of catalogues or otherwise."

W. E. RAMSAY,

Vice-President,

Pedlar People, Ltd.

Montreal, Que., February 24, 1922.

ENGINEERING PROBLEMS OF BOUNDARY WATERS

PROBLEMS of unusual difficulty in connection with international aspects of the control of boundary waters were discussed recently by J. B. Challies, Director, Dominion Water Power Branch, before the Engineering Society of the University of Toronto. In an impartial way, Mr. Challies outlined the nature of the contentions arising in connection with a considerable number of projects along the border from the Pacific to the Atlantic. Amongst other situations discussed were those of the Pend d' Orielle River which is related to the power situation at Nelson, B.C., the St. Mary and Milk River diversion, on which a decision has recently been reached by the International Joint Commission, the Lake of the Woods control problem, and the power and navigation problem in the international section of the St. Lawrence River, now become a very live issue due to the deep waterway agitation.

TRAINS FOR ROADS CONVENTION

INFORMATION has been issued by W. B. Howard, District Passenger Agent at Toronto for the Canadian Pacific Railway Co., regarding the cost of railway fares for those who expect to attend the annual convention of the Canadian Good Roads Association, which will be held in June at Victoria, B.C.

The summer tourist fare from Toronto, Ont., to Victoria, B.C., and return, limited to October 31, is \$133.30. A lower berth one way, Toronto to Vancouver, costs \$26.25. There is an additional charge of \$10.10 each way for routing via the Great Lake steamers from Port McNicol or Owen Sound to Port Arthur, but in this case the charge for berth is reduced.

Either the "Trans-Canada Limited," leaving Toronto at 9 p.m. June 8, or the "Vancouver Express," leaving at 10 p.m. June 8, will reach Victoria in time for the convention.

For those who desire to return immediately after the close of the convention, it will be possible to be in Toronto at 9 a.m., June 22.

For routing via the Great Lakes, it will be necessary to leave Toronto at 12:30 p.m., June 7, and by this routing the passenger could not arrive in Toronto after the convention until 11:55 a.m., June 23.

That the Ottawa Hydro-Electric Commission passed through a most successful and profitable year in 1921 is indicated by the annual statement and balance sheet submitted by J. A. Ellis, chairman of the commission. It shows a gross surplus for the year of \$61,791.96, after deducting all charges for maintenance and operation, power, interest, and sinking fund on \$700,000 debentures. Except for \$15,054.96, the surplus has all been carried to capital account for depreciations, renewals and extensions, or, in other words, the net surplus was \$15,054.96. The operating report shows revenue for the year of \$328,108.97. The outlook for 1922 is most encouraging, according to the report.

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COST DISTRIBUTION FOR THE ST. LAWRENCE WATERWAY

OPPONENTS of the St. Lawrence waterway in the United States are making loud protests concerning the distribution of the cost of the work, representing that it should be on a 50-50 basis, without regard to the economic characteristics of the two participating nations. It is stated that the United States is being asked to put up the major part of the cost of the Canadian waterway and that the proposed distribution of the expenditure is not acceptable to the people of that country.

Consideration of the situation shows that the basis of cost distribution recommended by the International Joint Commission is a most fair and equitable one. It is recommended that international navigation works be maintained and operated by the International Board, while national navigation works be maintained and operated by the country in which they are located, and that power works be built, installed and operated also by the country in which they are situated. The first cost of navigation works is to be apportioned on the basis of benefits received, that is, after a preliminary period of five years following completion of the work, the annual costs shall be assumed on the basis of the freight tonnage of each country actually using the waterway during the previous five year period. Navigation works for the combined use of navigation and power are to be paid for equally by the two countries.

It is difficult to see how a more equitable arrangement could have been discovered. If the United States is to enjoy the greater part of the benefit of the improved waterway for considerable time, surely it should be willing to assume the cost in due proportion to the benefit received. If, on the other hand, the benefits should at any time

be greater to Canada than to the United States there would be no objection on this side of the line to assuming full financial responsibility for such benefits. If it is stated that the waterway is an affair of greater interest and value to Canada than to the United States, then actual use would throw the greater part of the expenditure upon Canada and the Americans could have no possible cause for objection.

Engineering News-Record recently expressed the view that the first cost of the navigation works for the improved waterway would be met largely by the United States, and that the subsequent adjustment after the five year period following construction would apparently affect only operation and maintenance, which would represent a small percentage of the first cost. While we do not know that any definite statement has yet been made by the International Joint Commission on this point, it would seem obvious that the adjusted payments would cover total annual charges, including sinking fund on the bonds floated for the project. Under such circumstances the adjustment would affect first cost as well as operation and maintenance.

The statement that the principal beneficiary of the waterway would be Canada is scarcely borne out by consideration of the statements contained in the report of the International Joint Commission with respect to the resources of foreign and coastwise trade of each country within the country economically tributary to the waterway. There are in the tributary area of the United States some forty-two millions of people, while in the tributary area of Canada there are less than five millions. The production which is indicative of the resources of the two tributary areas is far greater within the tributary area of the United States than in that of Canada. Under such circumstances it is only reasonable to expect that a larger share of the cost of navigation works should be assumed by the United States than by Canada.

PROFESSIONAL LEGISLATION IN ONTARIO

THROUGH the pronounced opposition of the interests in Northern Ontario, it has become necessary to make a modification in the Professional Engineers' Bill now before the Ontario Legislature. It was represented by these interests that the long existing privileges of the prospector and mining operator would be encroached upon and that the bill would be intolerable to them. Rather than court the opposition of a considerable number of engineers and technical workers in the mining industry, the Advisory Conference Committee has agreed to an amendment of the bill which will render it inapplicable to those conducting mining or metallurgical operations.

While this procedure is undoubtedly the best under the circumstances, it is to be hoped that in the near future mining men will come in under such professional engineers' legislation as may be passed. No doubt a considerable number of professional mining engineers will take advantage of the prestige offered in registration and will become members of the Association of Professional Engineers, although such will not now be obligatory. When it is discovered that the professional engineers have no sinister designs on the mining industry, and greater confidence has been created, there no doubt will be a thorough consolidation of all professional engineering interests in the Province and through it adequate legislation both in the interests of the public and of the engineers themselves will arise.

PERSONALS

LIEUT.-COL. CARMICHAEL, minister without portfolio, and representative of the Ontario Government on the Hydro-Electric Power Commission has placed his resignation as a commissioner in the hands of Premier Drury.

W. C. SMITH, of Toronto, has been recommended to the City Council by the Water and Light Commission for

appointment as town engineer of Oshawa, Ont. Mr. Smith was formerly engineer for the Sumas Reclamation Project, New Westminster, B.C. If appointed, Mr. Smith will supersede N. G. McDONALD, the present town engineer, and also N. J. GOEBEL, the waterworks engineer, as the Board of Works has recommended the amalgamation of these two offices.

THOMAS W. HARVIE, the chief engineer to the Montreal Harbor Commissioners, was born in the parish of Old Monkland, Lanarkshire, Scotland, on August 5, 1877. He was educated at Gartsherrie Academy, Garnet-hill School and the Royal Technical College, Glasgow, winning distinction in most of the classes at the last-named institution. Mr. Harvie was a pupil for five years with Kyle, Dennison & Frew, civil engineers, and remained with this firm one year longer as assistant engineer, during



which period he was engaged on water supply, sewage and general engineering work. The following three years he was assistant resident engineer with the Caledonian Railway on heavy railway construction contracts. During the subsequent six years Mr. Harvie was on the engineering staff of the Clyde Navigation and acted as resident engineer on harbor construction. Mr. Harvie's next position was with Sir Robt. McAlpine & Sons as agent and engineer on York-hill Docks and other works for a period of three years. In 1910 Mr. Harvie was appointed assistant engineer on the engineering staff of the Harbor Commissioners of Montreal, and for three years was resident engineer on the construction of the new Victoria pier and market basin, riverside wharves and upper section of the harbor railways. In 1913 he was appointed assistant chief engineer in succession to A. D. Swan and from that date was in charge, directly under the chief engineer, of the various schemes of harbor extension and improvements. When W. F. Cowie was promoted to the position of consulting engineer to the Harbor Commissioners in February, Mr. Harvie succeeded him in the office of chief engineer. Mr. Harvie has had over 25 years of experience in engineering works, nearly 20 of which have been entirely devoted to harbor construction. Mr. Harvie is a corporate member of the Institute of Civil Engineers, London, and also of the Engineering Institute of Canada. He is a member of the Association of Professional Engineers of the Province of Quebec, and a member of the American Association of Port Authorities.

OBITUARIES

JOSEPH HALL, for nearly 50 years superintendent of the waterworks system at Windsor, Ont., died at the Hotel Dieu on March 6. Born in England 83 years ago, Mr. Hall came to Canada when he was 14 years old.

J. R. McCAILLUM, chairman of the Welland Water Commission, died recently at his home in Welland aged 76. The deceased was at one time a prominent contractor.

E. B. MCKAY, a former surveyor-general of British Columbia died in Edinburgh, Scotland, recently, aged 72. Mr. McKay was born in Scotland and came to Canada in

1875, and joined the staff of the Vancouver Coal Co. In 1883 Mr. McKay left Nanaimo and engaged in survey work on the Island railway. In 1889-90 he was in charge of a party which surveyed the Sutton timber lands, and in the latter year he entered the Government service as draughtsman. He was appointed surveyor-general in December, 1905, and continued in that capacity until 1911, when he was superannuated. He surveyed and laid out the town of Duncan, B.C.

Engineer's Library

BAROMETRIC CONDENSERS. Bulletin No. 9224 issued by the Canadian Ingersoll-Rand Co., Sherbrooke, Que., gives a clear understanding of the principles underlying condensation with particular emphasis on the importance of proper construction of counter-current condensers. The bulletin contains a comprehensive description of the barometric condenser, dealing with the construction and method of operation while a number of illustrations show the details of construction and several installations. Copies of the bulletin may be obtained from the head office of the company or any of the branches.

OIL PRODUCTION METHODS. A study of oil-producing methods is being made by T. E. Swigart, who is preparing a bulletin that will deal with the advantages and disadvantages of the various kinds of equipment used on producing oil wells, with methods of handling wells that produce by flowing, bailing, swabbing, and pumping, and methods for overcoming the many troubles encountered in this work. A paper on surface equipment for pumping wells is being prepared by H. C. George, petroleum engineer at the San Francisco field office of the United States Bureau of Mines. This paper will cover the many problems of power and of methods of connecting wells in order to reduce pumping costs.

A complete photographic survey of the proposed Great Lakes-St. Lawrence river deep waterway, with special sets of vertical and oblique photographs of points along the route where the different engineers suggested dams and locks, has been completed by the Ottawa station of the Canadian Air Board for the International Joint Commission. Surveys were also carried out over the old and new Welland canals, showing the progress made with the project.

The report of the investigation made by the United States Bureau of Mines at the Pittsburgh Station, relating to the value of coke, anthracite and bituminous coal for the generation of steam in the low pressure cast iron boiler, is being prepared for publication at a later date. The report shows the relative steaming values of the fuels and why the thermal efficiency varies with the different fuels. The draft required with the various fuels is carefully analyzed.

An Eastern Ontario Good Roads Association, whose object is "to protect the interests of the eastern part of the Province" in road construction, has been formed at Kingston, Ont. It is the intention of the new association to call a convention in Kingston in the course of the next few months to formulate new road plans and discuss the possibility of the extension of the Provincial highway system in the East. The contention of the organizers is that Western Ontario has been unduly influencing the Government's policy, and that the East must be organized to look after its own interests. It is claimed that, in respect to mileage, the west has dominated the whole program. It is pointed out that there are about 1,200 miles of highway in that portion of the Province, compared to less than 600 miles in the east, and that the east has but a single trunk line in the highway from Toronto to Montreal and Ottawa.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders	
	Close	Issue
Hamilton, Ont., construction of storm sewer	Mar. 22	Mar. 7
Ottawa, Ont., plumbing, heating, wiring, tinsmithing, roofing, plastering and painting	Mar. 15	Mar. 7
Regina, Sask., erection of Chemistry Building	Mar. 31	Mar. 7
Toronto, Ont., erection of school	Mar. 18	Mar. 7
Winnipeg, Man., erection of High School	Mar. 20	Mar. 7
Essondale, B.C., erection of addition to hospital	Mar. 24	Feb. 28
Raleigh Tp., Ont., erection of a school....	Mar. 18	Feb. 28

BRIDGES, ROADS AND STREETS

Barton Tp., Ont.—The Township Council decided to macadamize Crockett St., from East 32nd St. to East 36th St. Sidewalk improvements will likely be made on south side of Concession St. Clerk, A. G. E. Bryant, Hamilton.

Brantford, Ont.—City Engineer F. P. Adams will submit a program of proposed road improvements to the City Council at its next meeting.

Brantford, Ont.—The Provincial Highway in Brant County, between Brantford and Paris, will be graded and surfaced with gravel this season. On the west side of the county for a distance of about one mile a waterbound macadam base course will be constructed.

Brantford, Ont.—An extensive road program has been approved by the department of A. M. Jackson, County Engineer, including the laying of about 2½ miles of 9-ft. pavement along the Burford Road. The Mount Pleasant Road is to be further graded next fall in preparation for concreting the following year. Filling will be continued on the Cockshutt Road; Burford Road will be gravelled in that area directly under the county jurisdiction; grading will be carried out near Oakland for a distance of some two miles; and general road work on the Burford, Norwich and Hatchely roadways will be undertaken. The road through the village of St. George will also be rebuilt, and two miles more grading carried out at the end of the Blossom Road.

Calgary, Alta.—The City Commissioners are considering the widening of Seventeenth Ave. West.

Calph, Ont.—The City Council passed a by-law providing for the raising of \$62,431.10 for the construction of pavements. City Engineer, F. McArthur.

Hamilton, Ont.—The Works Committee will have sidewalks completed on Tragina Ave. and Weir St.

Hamilton, Ont.—The Board of Works is considering the widening of York St. near the high level bridge, and the extension of Glenferrie Ave.

Hamilton, Ont.—The paving of King St., from James St. to Bay St., and Wentworth, Locke and Margaret Streets is planned. City Engineer, E. R. Gray.

Hamilton, Ont.—The opening up of the mountain roadway, from Sherman Ave. east to Ottawa St., has been suggested as a means of providing more employment.

Hamilton, Ont.—Wentworth County Council will spend \$60,000 on the construction of roadways on the main thoroughfares of Beamsville and Grimsby. Road Superintendent, T. R. Allison, Hamilton.

Hamilton, Ont.—The "jack knife" bridge at the Hamilton Beach canal is nearly completed and will be opened about March 25, when automobile traffic across the beach, which has been cut off for over a year, will be resumed.

Hamilton, Ont.—The Works Committee decided to pave Mary and Catharine Streets, from Cannon to Barton Streets. The paving of Dundurn St., from York to King Streets, is under consideration. City Engineer, E. R. Gray.

Hull, Que.—A resolution calling upon the Quebec Provincial Highways Department to designate the road from Hull to Maniwaki as a provincial highway was adopted by Ottawa County Council.

Kitchener, Ont.—The City Council instructed Stanley Shupe, City Engineer, to obtain quotations on a carload of cement.

Kitchener, Ont.—The City Council decided to complete Woodlands Ave. grading. A sidewalk will be constructed on the south side of Baurice St., between South and Sidney Streets. City Engineer, S. Shupe.

Manville, Alta.—The council of the Municipal district of Melberta No. 483 will urge the Government to construct a bridge across the Vermilion River. If the Government builds a bridge, the municipality will build a road.

Penticton B. C.—According to Provincial Road Engineer W. K. Gwyer, an extensive road program is to be carried out in this district during the coming season, necessitating the employment of more than 1,000 men. Among the most important work is the construction of 35 miles of trans-continental road from Hope to Princeton. Tenders for the work will be called shortly. The 19 mile gap in the trans-provincial highway between Christina lake and Rossland will be finished this year. Most of the other work will consist of improvements to existing roads, particularly along the Okanagan lake shore and on the Oliver project road, which will probably be extended to Osoyoos.

St. Catharines, Ont.—The Dominion Railway Board has ordered the Grand Trunk Railway to have completed by June 30, this year, a new overhead bridge on St. Paul St. West.

Simcoe, Ont.—The Provincial Highway Department plans to undertake the following work in Norfolk County: West from Simcoe 12 miles of road will be graded and gravelled; an additional 8 miles will be gravelled, making a total of 20 miles west from Simcoe which will receive a substantial surfacing of gravel. In the town of Simcoe a bridge with a 40-ft. span will be constructed. All the culverts between Tillsonburg and Jarvis will be, it is expected, placed under contract within the next few weeks. The three miles of Provincial highway at the end of the county will be surfaced.

Toronto, Ont.—The City Council referred back to the Works Committee the proposed extension of Riverdale Ave.

Toronto, Ont.—The City Council passed the necessary by-laws for the extension of Dundas St. across Yonge St.

Toronto, Ont.—The Works Committee recommended the extension and grading of Patterson Ave., at a cost of \$15,500.

Toronto, Ont.—The City Council decided to call for tenders for the construction of bitulithic pavement on Coleman Ave.

Toronto, Ont.—The City Council rejected the proposed widening of Bloor St., from Sherbourne St. to Spadina Ave.

Toronto, Ont.—The City Council intends to construct an asphalt pavement on Chestnut Park, at an estimated cost of \$49,989.

Toronto, Ont.—The Board of Control recommended that tenders be called for the construction of an asphalt pavement on Coleman Ave.

Toronto, Ont.—The Works Committee recommended the adoption of the report of Commissioner Harris for the opening of a lane 12 ft. wide, between Keele St. and Mavety St., at a cost of \$2,475.

Toronto, Ont.—Mayor Maguire announced that if the railway companies will build their proposed bridge over the tracks at the foot of Spadina Ave., the city will not have any objection to their doing so. This statement was made in reference to the application made some time ago by the railway companies to the Dominion Railway Commission, but held in abeyance. The Mayor has received a plan of such a bridge.

Toronto, Ont.—The chief engineers of the C.P.R. and G.T.R. recently held a conference with Mayor Maguire and Works Commissioner Harris on the question of eliminating the level crossing on Bloor St., between Dundas St. and Lansdowne Ave. Mr. Harris has prepared plans for a subway under the east tracks and a bridge over the west. These are to be considered by the railways, and the city will be further advised as to whether they will consent to the plan. The matter will then be submitted to the Railway Board for a division of the costs.

Toronto, Ont.—The Works Committee recommended the adoption of the reports of Works Commissioner Harris for the construction of the following work: Raglan Ave., concrete walk on east side, \$614; Fairford Ave., Morley Ave. to Coxwell Ave., asphalt pavement, \$24,316; Maughan Crescent and Hemlock Ave., Edgewood Ave. to Robbins Ave., asphalt pavement, \$16,589; Wabash Ave., Sorauron Ave. to east end, asphalt pavement, \$36,197; St. Clair Ave., concrete pavement, \$35,348; curbs on Fairford Ave., Hemlock Ave. and Maughan Crescent, \$3,366; concrete sidewalks on Gifford St., Glendonwyne Road, Nasmith St., Glebeholme Blvd., and Ashdale Ave., \$15,132.

Victoria, B. C.—The following tenders were opened recently for the construction of the steel railway portion of the Johnston St. bridge: Canadian Bridge Co., Ltd., Walkerville, Ont., for supplying the steel and preparing it for assembly, \$159,900, and for completing the structure, \$213,400; John Coughlan & Sons, Vancouver, agree to do the same for \$175,000 and \$212,500, respectively. William Arrol Co., Ltd., Glasgow, Scotland, \$186,156 for the supply and fabrication of the material. The tenders were referred to the public works committee.

Windsor, Ont.—This city's share of the cost of paving 14 miles of county and provincial highways in the Windsor suburban area, which extends to Essex, is approximately \$150,000. It is proposed to ask the Provincial Government to complete this work in two years.

WATER, SEWAGE AND REFUSE

Guelph, Ont.—At a recent session of the Dominion Railway Board held here a new plan for the proposed Grand Trunk freight sheds was presented by E. A. James, consulting engineer, Toronto, who was employed by the city to prepare same.

Oliver, B. C.—It is expected that the government expenditure on the large irrigation project here this year will be approximately \$400,000.

Oshawa, Ont.—The Grand Trunk Railway Co. will immediately erect a 75,000-gallon water tank here.

Ottawa, Ont.—The City Council authorized the Board of Control to call for tenders for the construction of the Emmett St. sewer.

Ottawa, Ont.—The City Council awarded the following

contracts in connection with the Overland Pipe Extension: For special pipe castings, Victoria Foundry Co., Ottawa, at \$6.18 per cwt.; expansion joints, Canadian Des Moines Steel Co., Ltd., Chatham, Ont., one expansion joint, \$281, and four expansion joints at \$319 each.

Quebec, Que.—Power has been given to the Quebec Streams Commission to build a gigantic dam on the Ouareba River in the Laurentian Mountains, beyond St. Agathe, at a cost of \$250,000. The work is to be started this spring, and will include the erection of storage dams at Lakes Ouareba, Archambault and Blanc.

Toronto, Ont.—The Works Committee recommended the adoption of the report of Commissioner Harris for the construction of a 6-in. water main on Nursewood Road at a cost of \$2,775.

Toronto, Ont.—The Works Committee recommended the adoption of the reports of Commissioner R. C. Harris for the construction of sewers on Small St. and Simpson Ave., to cost \$1,770 and \$4,200 respectively.

Toronto, Ont.—The contract for the laying and jointing of water pipes on Larchmount Ave., Berkshire Ave., Rushbrooke Ave., Marigold Ave., and Eastern Ave. has been awarded to the Grant Contracting Co., Ltd., Toronto.

Vanconver, B.C.—City Engineer Fellowes' has recommended the laying of another 18-in. pipe across the First Narrows, at a cost of \$33,000.

Vanconver, B.C.—The contract for supplying the city with 2,200 ft. of water pipe, at \$2.88 a foot, has been awarded by the City Council to the Vulcan Iron Works.

Windsor, Ont.—Engineer Keith of Essex Utilities Commission is preparing data which is expected to show that the commission will be able to supply filtered water to the border municipalities at lower rates than the Walkerville Water Company. Officials of the commission are certain that a joint filtration system will be more economical than individual units at Walkerville and Windsor. Under the plan of the commission all the municipalities will control the distribution systems.

York Tp., Ont.—The Township Council instructed Engineer R. O. Wynne-Roberts to prepare plans of the proposed sewerage lines for the suburban areas of the township.

York Tp., Ont.—The Township Council will have permanent culverts constructed on Nairn Ave., Ennerdale Road, Holmesdale Road, Harvey Ave., Blackthorn Ave., and First Ave. Engineer, Frank Barber, Toronto.

LIGHT, HEAT AND POWER

Barton Tp., Ont.—The Township Council passed a resolution asking the Hydro-Electric Power Commission of Ontario to incorporate that section of Barton Township which is situated below the mountain with the Saltfleet rural distribution system. Also that the commission be asked to prepare a statement on the cost of segregating the Barton township distribution system.

Bridgeburg, Ont.—The Town Council appointed a committee consisting of Mayor W. T. Malkin and Councillors Williams, Atwood and Hogg, to take up the question with the Hydro-Electric Power Commission of Ontario of bringing the Hydro into Bridgeburg. The Commission will start the construction of a line from Chippawa to Stevensville shortly and Bridgeburg will almost be touched by this line.

Kingston, Ont.—The Utilities Commission will proceed at once with the changing of the power lines on Ontario St. About 25 steel poles will be erected.

London, Ont.—The improvement of the city's street lighting is projected. It is understood that \$60,000 or \$75,000 will be available for this purpose.

Montreal, Que.—It is believed that the Montreal Public Service Corporation contemplate developing power on the Kipawa river in Pontiac County where 90,000 h.p. can be generated. This corporation is seeking powers to

construct transmission lines in twenty-three counties in this province.

Penticton, B.C.—The Municipal Council will have work commenced shortly on the installation of an electric pumping plant. Estimated cost, \$12,000. Clerk, B. C. Bracewell.

RAILWAYS

Calgary, Alta.—The street railway department has applied to the city commissioners for authority to call for tenders for 35 tons of steel rails, to be used on Centre St.; an electric welding outfit; and a Ford truck to be used as a tower for work on the overhead lines.

Galt, Ont.—The Public School Board decided to erect an 8-room school. Chairman, C. K. Jansen.

Hastings, Ont.—John Coughlin has offered the School Boards a free site for the erection of a public or High School.

London, Ont.—Several thousand dollars will be spent for repair work throughout the London division of the G.T.R., and work will commence shortly. The Grand Trunk will continue laying new 100-pound steel rails between London and Sarnia.

Montreal, Que.—The Knights of Columbus are inaugurating a campaign to raise \$250,000 for the erection of a clubhouse.

New Toronto, Ont.—A by-law will be submitted to authorize an issue of debentures amounting to \$75,000 for the erection of the proposed new school.

St. Catharines, Ont.—Mayor Graves is pressing for some action here to get under way the proposed extensions and improvements on the local street railway and on the suburban lines of the N. S. and T. Railway. Alderman J. E. Riffer, chairman of the Railway Committee, has called a conference of all the municipalities, and will submit the assurance from Sir Adam Beck that there is no reason why extensions and improvements cannot be carried out by the present owners and the cost added to the option price. Pressure will be brought to bear to have some action taken at once.

Swastika, Ont.—The Canadian Light Railway Construction Co. has asked the Ontario Government for support in the construction of a light railway through the outlying mining fields of this district. It is planned to build standard gauge lines.

Toronto, Ont.—This year's rehabilitation program of the Toronto Transportation Commission calls for an expenditure of approximately \$11,000,000.

Toronto, Ont.—The Separate School Board will erect schools in Moore Park, an 8-room school on Jane St., a 10 room school in the vicinity of Ossington Ave. and Dewson St., and a 1-room school in the neighborhood of Dundas and Bloor Streets. Also a 4-room school in Fairbank district. Chairman, David Carey.

Toronto, Ont.—Ward Two Ratepayers' Association will ask the Toronto Transportation Commission to extend the street car tracks up Parliament to Bloor St. The Association will also urge upon the commission the need of establishing a cross-town car service, by way of Danforth Ave., Bloor St., Parliament St. and Queen St. to Sunnyside.

Waterloo, Ont.—Plans for the erection of a parish hall for St. John's Lutheran Church will be completed shortly. Estimated cost, \$40,000. Address Joseph Ludwig.

FACTORIES AND LARGE BUILDINGS

Beeton, Ont.—The School Board awarded the contract for the erection of a school to E. H. Horton, of Hamilton.

Berwick, N.S.—W. O. Bilgic intends to erect a two-storey theatre 90 by 40 ft., on Commercial St.

Brechin, Ont.—Plans are being prepared for the early commencement of work on the new High School for the Scarborough district, to be erected at Scarborough Junction.

Bridgeburg, Ont.—An Anglican parish hall will be erected at the corner of Central and Emerick Avenues.

Calgary, Alta.—The School Board will submit by-laws to raise \$60,000 to remodel certain schools.

Calgary, Alta.—The congregation of the Central Christian Church plan the erection of a three-storey edifice at the corner of Fifteenth Ave. and Sixth St. West. Pastor, Rev. Burton Davies. Tenders will be called. The congregation has in view the construction of a third unit to be used as the church auditorium in the not distant future.

Edmonton, Alta.—The Board of Education is considering the provision of additional school accommodation.

Edmonton, Alta.—Sketch plans of the proposed new Isolation Hospital have been prepared by City Architect J. Martland. Estimated cost, \$200,000.

Ettobicoke Tp., Ont.—Walker & Gibson, architects and engineers, 70 Victoria St., Toronto, have been retained by the Trustee Board of School Section No. 11, to design and supervise the construction of a six-room addition to the present school building. The old building is to be overhauled and made more fire proof.

Ford City, Ont.—School Board plans the erection of a school on Charlotte St. at a cost of \$100,000. Tenders will be called. Architect, A. H. McPhail. The erection of a school in the Drouillard Road district is under consideration.

Galt, Ont.—The School Board is having plans prepared for an eight-room school and tenders will be called.

Galt, Ont.—High School Inspector Rogers has recommended the erection of an addition to the Collegiate Institute.

Guelph, Ont.—A special committee has approved plans submitted by Architect George Hutton, of Hamilton, and decided to call for tenders for the new Collegiate Institute, which will cost approximately \$320,000.

Hampton, N.B.—The grist mill owned by W. H. Hill was destroyed by fire recently. Loss, \$14,000.

Kingston, Ont.—Plans are being prepared by Stevens & Lee, architects, for the proposed infectious building in connection with the General Hospital.

Kingston, Ont.—Ettobicoke Township Council authorized the issuing of debentures amounting to \$90,000 for the construction of a school at Humber Bay.

Jarvis, Alta.—The local branch of the U.F.A. plans the erection of a hall. Secretary-Treasurer, H. H. Lee.

Kingston, Ont.—There appears to be every possibility that the Eastern Ontario Dairy School, recently destroyed by fire, will be rebuilt in this city. A scheme is now before the Government, and it is expected that a decision will be made shortly.

Kitchener, Ont.—The Dominion Shirt Co. plan the erection of a new factory.

Kitchener, Ont.—The Greb Shoe Co. plans the erection of an addition to their premises.

Kitchener, Ont.—The contract for the construction of St. Peter's Parish Hall has been let to Durker Bros., of this city.

Mimico, Ont.—A \$90,000 public school building is to be erected in the township, east of the Mimico municipal boundary.

Mimico, Ont.—The Official Board of Mimico Methodist Church decided to erect at the corner of Station Road and Mimico Ave. a church school building. Pastor, Rev. J. O. Johnson.

Montreal, Que.—Power to borrow several million dollars to build a new City Hall here will be granted by the Provincial Legislature.

New Toronto, Ont.—Charles Langley, chairman of the finance and management committees of the New Toronto Public School Board, announced that the trustees are proceeding with the project of building an eight-room public school. Estimated cost, \$75,000.

Niagara Falls, Ont.—The Brant Creameries will erect a two-storey brick, concrete and steel building on Simcoe St.

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Power Development at High Falls, Que.

Possibilities for Power Development on Lievre River — Will Open Up Region Rich in Minerals for Industries — Two Falls Near Buckingham, Que., Supply Power for Electric Reduction Co. and McLaren Lumber Co.

BY A. LANGLOIS

WITH THE great water powers at High Falls, near Buckingham and all along the river from Buckingham to its mouth, adding the 25 miles of inland navigation, the Lievre River Valley should become a most prosperous section of the Province of Quebec.

Besides its water powers, the region possesses almost unlimited forests together with fertile plateaux surrounded by mountains of graphite, mica and phosphate deposits. Only a fraction of the power possible of exploitation on the river has as yet been utilized.

River Drains Large Area

The Lievre River which takes its source about 225 miles to the north, flows into the Ottawa River at a point 18 miles east of Ottawa city. The total drainage area of the river is 4,050 sq. miles. Its average annual flow is about 3,000 c.f.s., but this could possibly be increased with proper conservation of the water from the lakes and tributaries. The extreme fluctuations of the river are low.

About 30 miles from its mouth, the river begins a series of falls and rapids of great importance. The first called the High Falls, is situated about 40 miles from Ottawa. In 1913 a dam was built at High Falls by the McLaren Lumber Co. of Buckingham. The dam is of modern type built of concrete throughout. It measures 600 ft. in length and averages 35 ft. in height, and is composed of nine piers and abutments. The dam is provided with three regulating sluices and a concrete log slide measuring 650 ft. in length. The head at the dam is 150

ft. This great water power readily available is near several towns but has not been developed.

From High Falls the Lievre River is navigable as far as the town of Buckingham, a distance of 25 miles. A lock is necessary, however, at Poupore, half way down.



DAM AT HIGH FALLS DURING CONSTRUCTION

to overcome a fall of 8 ft. This lock and the necessary dam and approaches were built by the Department of Public Works in 1892, but were considerably improved lately. The lock is built of masonry, and measures 150 ft. long by 31 ft. wide by 8 ft. on the sills. The minimum depth of the channel is 9 ft.

Development at Buckingham

A Buckingham there are two magnificent concentrated falls which are at present being developed to full capacity. The two falls are only a short distance apart. The power developed on the upper falls is utilized by the Electric Reduction Co., excepting a small reserve to the town of Buckingham water works.

The Electric Reduction works are situated on the site of an old granted property and water power, where many years ago it was proposed to build a pulp mill, but which was bought by W. A. Williams, of England who, in company with the late W. F. Gibbs, a chemist and inventor, made a number of experiments on the possibilities of utilizing the enormous phosphate deposits of the Lievre River Valley, with the intention of erecting there, mills for the reduction of the ore. Mr. Gibbs was entirely successful



DAM AT BUCKINGHAM DURING CONSTRUCTION

in his experiments, at the same time discovering the means of using electricity for the reduction of the mineral in electric furnaces. Extensive developments have taken place since, and the company is today splendidly



COMPLETED DAM AND POWER HOUSE OF ELECTRICAL REDUCTION CO., BUCKINGHAM, QUE.

organized to extract the phosphate from the inexhaustible deposits in this region.

Electric Reduction Co. Development

The dam and power house of the Electric Reduction Company were built in the years of 1918-19. The works there, as well as those at High Falls, were constructed under the supervision of John B. McRae, consulting engineer of Ottawa. The dam is built of reinforced concrete throughout. It comprises a log slide, five sluiceways controlled by stop logs, and a long spillway adjacent to the power house which is also entirely built of reinforced concrete. Three units are in operation at the present time, and provision has been made for two more to be used when the company has completed its proposed improvements to the mills, when it will then absorb all the power possible of development there. The head at the dam is 32 ft.

There is another concentrated fall at a few hundred feet down the river, the property of the McLaren Lumber Co. There, also, the extensive developments are under way, and it is said that the cost of the present improvements will be in the neighborhood of one and a half million dollars. The level at which it is proposed to maintain the water surface at the dam, will give an approximate head of 60 ft. The company operates two large saw mills, and a pulp mill having a capacity of 100 tons of pulp a day.

From the foot of the lower fall at Buckingham to the mouth of the Lievre River, there remains a total drop of 200 ft. distributed over a distance of about 2 miles and terminating by a concentrated fall of about 40 ft., situated at the intersection of the river with the Canadian Pacific Railway main line, the banks of the river at that point contributing to the development of the falls which are also divided in two branches, separated by a rocky island. These last mentioned falls are only 18 miles east of Ottawa city.

IRRIGATION STRUCTURES DISCUSSED

AN INTERESTING paper on "Actuarial Factors in the Design of Irrigation Structures" written by H. B. Muckleston of the Lethbridge Northern project was read by G. P. F. Boese, assistant engineer of the C.P.R. Natural Resources Department, before the Calgary branch of the Engineering Institute of Canada at the Board of Trade rooms, Calgary.

The economic problem in the design of water storage works is usually studied under five heads, as follows:

Determining the economic value of storage.

Determining the available storage from the run-off records over a series of years.

Determining the capacity curve for a wide range of dam heights.

Determining the unit of curve for a wide range of capacities.

Determining the economic storage capacity to be developed.

The reader then dealt conclusively with each of the above factors, giving a wealth of data and figures, gleaned by the experience taken from scores of irrigation projects, during the history of this phase of artificial water supply.

Possible floods to be provided against is the most important question entering into the consideration of the spillway. Given enough time, any size of flood may occur on any size of stream.

The various causes of high water in these latitudes are six in number: (a) a heavy winter snowfall in the mountains; (b) a late quick spring; (c) heavy rain in the water-shed; (d) precipitation on previously saturated catchment areas; (e) precipitation in which the storm centre moves down stream; (f) breaking of logs and ice jams, beaver dams, etc.; and (g) destruction of other storage works higher up in the valley. Any combination of these causes may occur together, resulting in anything from slight damage to disaster, or any one of them may cause high water or perhaps moderate floods.

He then gave a table showing how frequently each of the above causes, except the two latter, is operative on the average.

Cost Not Constant

The cost of maintenance is not constant, but will vary somewhat with the height, length of spillway, area of surface protected by rip-rap, or other means, and with other factors of more or less special application. Every irrigation canal, in the upper reaches at least, crosses the country drainage. This drainage must be taken care of either by taking it into the canal or passing it across.

The reader then went exhaustively into the figures giving the financial aspects of the structure. Absolute permanence is not a possibility, even the eternal hills decay. What is usually meant by permanence is a useful life so long that the annual charge to replacement account is practically zero. Even this kind of permanence is not always economical; for it may cost more than it is worth. But there is for each individual case a useful life which in the long run is the most economical.

Takes Extreme Case

It is frequently possible, by refinements in design, to save a considerable annual amount in the cost of operation; and as an extreme case he took a system where all the distribution is by means of closed channels. In this case, provided the pipes could stand the pressure, there would be very little cost properly chargeable to delivery of water, as each used would open and close his outlet at his own convenience. Such a happy state is however, seldom practicable.

In conclusion Mr. Boese said: "The best design in irrigation structures it not necessarily the cheapest in first cost of operation, but the design is as dependent upon the financial foundation as it is on its structural foundation."

At a meeting of the Hamilton branch of the Engineering Institute of Canada recently, a paper was read by F. W. Farmer, of the engineering staff of the Ontario Hydro-Electric Power Commission, on the electrical power plant at Queenston.

A most interesting and instructive lecture was delivered before the Engineering Society of the University of New Brunswick, at Fredericton, N.B., on March 9, by F. P. Vaughan of the Vaughan Electric Co., St. John, on the phenomena of high frequency currents. Mr. Vaughan demonstrated the effects and discharges by means of a number of pieces of valuable high frequency experimental and test apparatus which he recently donated to the science department of the University and valued at approximately \$2,000. With the addition of this apparatus to the equipment of the science department, wide fields of research work have been opened up to the students in the electrical course which is offered at the University.

INTERCEPTING SEWER IN THE ESSEX BORDER DISTRICT*

Sewer Serves Seven Municipalities Along Detroit River — Description of East and South Interceptors, and Pumping Stations — River Freed from Pollution

M. E. Brian, O.L.S.; A.M.E.I.C.
City Engineer, Windsor, Ont.

BORDERING on the Detroit River in the Province of Ontario there are seven incorporated municipalities — Tecumseh, Riverside, Ford, Walkerville, Windsor, Sandwich and Ojibway — with adjoining boundaries along the river for ten miles. The entire district is very flat and the drainage of each municipality in relation to its downstream neighbor, created a distinct problem which could not be solved without joint action between them.

In 1914 the International Joint Commission issued their first progress report and in it, the fact was stated that the entire Detroit River was polluted by the municipalities of Windsor, Walkerville and Sandwich, and across the International Boundary, in the State of Michigan by the cities of Detroit, Wyandotte and Trenton. It further stated that the intakes of the Windsor and Walkerville waterworks systems, were exposed to pollution owing to the discharge of sewage above them.

In 1916 a second report was published dealing with the prevention or remedy of this pollution. It advocated the formation of a drainage district along the Detroit River in order to avoid friction and duplication of effort which would result by each municipality endeavoring to solve its own problems.

Essex Border Utilities Commission Formed

In 1916, the Essex Border Utilities Commission was constituted by special act of the Legislature at the request of several of the municipalities along the Essex Border, which had common problems that could not be satisfactorily settled by the municipalities individually. The Commission had for its object, the solution of problems which affected the entire district as distinct from those affecting any one in particular. The personnel of the Commission included the Mayor and one elected representative from each of the municipalities in the Metropolitan District.

To consider the various problems, the engineers of the district constituted a board, consisting of the late Owen McKay, representing Ford City and Walkerville; M. E. Brian, representing Windsor; C. R. McColl, representing Sandwich Town; J. J. Newman, representing Sandwich West Township, and Morris Knowles, C.E., representing Ojibway. The writer, city engineer of Windsor, was appointed chairman. The Board recommended that an engineer be retained by the Commission to make a report on a metropolitan water supply and sewage system, and as a result, the Commission appointed Morris Knowles, C.E., of Pittsburg, Pa.

Report Recommendations

A single joint sewage scheme to protect the entire water front was proposed as being most economical, both in first cost and operating charges. In brief, the report recommended an intercepting sewer parallel to the river front, extending from Pellette Road in Ford to 14th Street in Ojibway, with a disposal plant in Sandwich between Chewett and Detroit Streets. As an economic factor, the plant was designed for domestic sewage only, with storm overflows into the river, as all sewage would require to be

pumped on reaching the disposal plant. Two recommendations were incorporated in this report for immediate consideration.

(1) That the sewage of Ford and Walkerville be collected at once in an intercepting sewer and be delivered to a pumping station in Walkerville and there lifted to an intercepting sewer connecting with the Parent Avenue outlet, thus removing all sewage from the river above the present intakes.

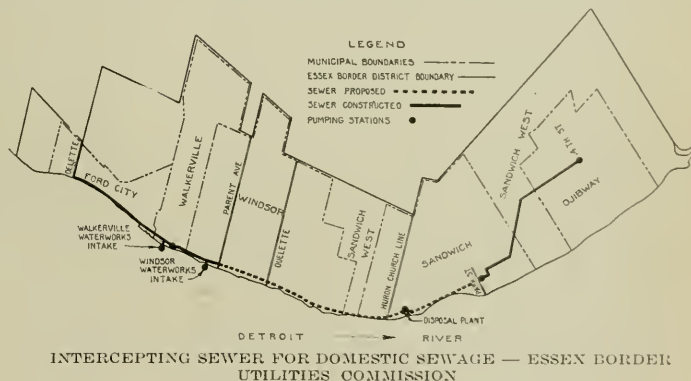
(2) That an intercepting sewer be constructed through portions of Ojibway, Sandwich West, and Sandwich, which would deliver the sanitary sewage from these districts into an existing outlet on Park Street in the Town of Sandwich.

In March, 1918, the work embraced in the foregoing recommendations, was approved by the electors of all municipalities by a vote of seven to one.

Cost Apportioned Among Municipalities

The estimated cost of the work, based on labor and material prices in 1916, was \$210,300. The cost was apportioned among the various municipalities upon the basis of four factors, area, population, capacity and capacity times distance, with some minor modifications to govern special conditions and was as follows: Ford, \$65,300.00; Walkerville, \$18,600.00; Windsor, \$26,200.00; Sandwich, \$25,333.34; Sandwich West, \$28,333.33; Ojibway, \$46,533.33; Total, \$210,300.00. The estimated costs were considerably exceeded as the work was carried out in 1918-19-20, when labor and material were at the highest level.

The work divided itself naturally into two sections,



easterly and southerly, and while in progress was referred to as the east and south interceptors. Detailed surface and underground surveys of Sandwich Street, from Pellette Road in Ford, to Parent Avenue in Windsor, were made by the late Owen McKay, while similar surveys were made for the south interceptor by Messrs. McColl and Fletcher.

The quantities of vitrified tile sewer involved in the east interceptor, were as follows: 942 lin. ft. 15 in.; 1469 lin. ft. 18 in.; 1555 lin. ft. 20 in.; 2585 lin. ft. 24 in. The quantity of segment block sewer used was 2037 lin. ft. 30 in. and 3709 lin. ft. 33 in. There were 48 manholes in addition to measuring chambers and regulators.

Regulators at Junction of Two Sewers

The existing outlet sewer and drains in Walkerville and Ford, carried both storm water and sanitary sewage. To divert the dry weather sanitary sewage into the interceptor and allow the storm water to continue into the river, regulators were designed and built at the junction of the two sewers. The regulators consist of two compartments built adjacent to the combined sewer, one directly connected with it, containing a float which rises and falls with the flow in the combined sewer, the other section connected by means of an 8 in. x 12 in. opening with a cast iron bronze faced sliding

*Paper read at the Thirtieth Annual Meeting of the Association of Ontario Land Surveyors, Toronto, Feb. 21-23.

gate. This gate is connected to the float through lever rods so arranged that the sanitary sewage is at all times diverted into the interceptor. During a storm, the float rises, which in turn partially closes the slide gate, allowing a diverted flow, equal to the maximum sanitary flow from the drainage area, into the interceptor. The lever and float are so arranged that they may be adjusted to meet the increased discharge of the growing district. A dam of sufficient height is constructed in the combined sewer to divert the sanitary flow to the interceptor. These have now been in operation for almost two years and have been found positive in action at all times. In Walkerville, it was necessary to install a tide gate in one of these structures, otherwise the Detroit River at its maximum recorded elevation, would flow into the interceptor.

While several factors were involved in the apportionment of construction costs, the maintenance charges are in direct proportion to the amount of sewage delivered by each municipality. To this end measuring chambers were erected at the municipal boundaries. Measurement is made in each case by a Venturi meter connected to an indicating and recording register, from which daily charts are obtained. By simple subtraction, the amount of sewage from each municipality can be ascertained.

East Sewage Interceptor

To complete and put into operation, the east sewage interceptor, a pumping station, was necessary near the boundary between Windsor and Walkerville. This avoided a high lift for all the sewage at the disposal plant and eliminated excessive depth of sewers across the city of Windsor. The east interceptor was designed of sufficient capacity to carry the sewage flow from Ford and Walkerville, when both municipalities would be completely built up. The pumping equipment for this station must, therefore, be capable of lifting this flow and after being selected, the station was designed to accommodate it.

The station is 24 ft. in diameter and 22 ft. deep, constructed throughout of reinforced concrete. The lower compartment contains the pumps, while the motors, float, switches, meter registers, etc., are located on the upper floors. An annular wet well is provided around the pump room to distribute the sewage from the interceptor to any one or more of the pumps. The upper part of the wet well is enclosed to form a force main and receive the discharge from the pumps placed three feet below the interceptor to make them self priming.

Four complete pumping units will ultimately be installed, two being in place at the present time; one of which serves as a spare except in short period of maximum daily flow. Each unit consists of one 2000 i.g.m. vertical centrifugal Yeomans sewage pump, direct connected to a 20 h.p. 3 phase 25 cycle 220 volt. 500 r.p.m. induction motor. The station is automatic in operation, the motors being started or stopped by a float operated switch attached to a copper float, actuated by the rise and fall of sewage in the wet well. The station is entirely underground, access being available through a small brick superstructure of pleasing appearance. It has been in operation for almost two years and during that time all sewage from the towns of Ford and Walkerville, has been discharged below the intakes of the Windsor and Walkerville waterworks.

South Sewage Interceptor

The south Interceptor extends from 14th St. in Ojibway follows Main, Sandwich and Russell Streets to Park Street and is 12,930 ft. long. It was designed to care for the domestic flow from Ojibway, Sandwich West and the southerly half of Sandwich. The sewage of Ojibway will be received at a pumping station to be constructed near 13th Street by the city of Ojibway, and will be raised and delivered to the interceptor at this point. There were no existing sewers in the district traversed by this portion of the interceptor and special structures of any kind were unnecessary. Lock joint pipe was used, and in the following

quantities: 5690 lin. ft. of 27 in.; 4370 lin. ft. of 39 in. and 2800 lin. ft. of 42 in. There are 27 manholes.

This work presented many construction difficulties, the greater part of it being through water bearing sand. Sheet steel piling was used for a short time but was abandoned and the trench opened with a clam shell bucket, until the sides stopped sliding, the trench in places being 25 ft. wide. While the yardage excavated was excessive, more rapid progress was made and at less cost than by driving and pulling the steel piling.

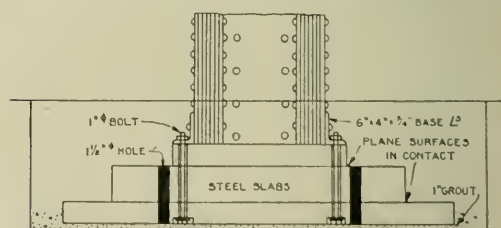
A temporary pumping station was constructed at Park Street to lift the sewage into an existing sewer. This will be of no further use when the interceptor is continued to the proposed disposal plant.

With the completion of these two sections of sewer, and the auxiliary structures, the recommendations contained in the engineer's report had been acted upon, nine sewage outlets had been eliminated and the river front freed from domestic pollution, for a length of five miles. The time is probably not far distant when the International Joint Commission will issue an order that the pollution of Boundary waters must cease. With the completion of the section across the city of Windsor and part of the town of Sandwich, and the construction of the disposal plant, the order will have been complied with in so far as it concerns the Essex Border District. In conclusion the writer desires to record his indebtedness to J. C. Keith, now chief engineer of the Essex Border Utilities Commission, for facts and plans.

IMPROVED STEEL COLUMN FOOTING

UNTIL recently the accepted method of constructing a spread footing for a steel frame building has been by the use of steel grillages. An important departure from, and improvement on, this practice has, however, been made by Eugene W. Stern, consulting engineer, New York, and a graduate of the University of Toronto. This consists of utilizing layers of rolled steel slabs, laid one on top of the other with their contact surfaces planed. Footings of this type have been used by Mr. Stern for some time with marked success and economy.

For light loads, single steel slabs have been used by many designers, but the replacing of heavy footings by a tier of slabs is believed to be novel. This construction not



COLUMN FOOTING

only is cheaper than grillage construction, but it takes up much less depth—an important consideration where rock excavation is necessary. Slab footings are also much cheaper and more dependable than steel castings.

In design, Mr. Stern believes that for an unyielding foundation, the cantilever method is perfectly safe, assuming a permissible flexural stress of 16,000 lb. per sq. in.

The accompanying illustration shows a footing 82 in. square supporting a column with a load of 3,400 tons and transmitting this load to a hard rock foundation. If this footing were properly built up of grillage beams, its cost would be almost double that for the design shown.

The Montreal Water Board now consists of Ald. Brodeur, chairman, S. Fortin and H. A. Turreault. The services of Messrs. R. S. & W. S. Lea and Walter J. Francis have been retained as consulting engineers to the Board.

THE MONTREAL SITUATION WITH REFERENCE TO TOWN PLANNING*

Rapid Growth of City and Lack of Definite Plan — Traffic Congestion — Need for Comprehensive Plan — Should Co-operate With Railways

By James Ewing, M.E.I.C.

IN THE last thirty years the city of Montreal has grown fully five times over, or twice as fast as the Dominion of Canada itself. This astonishing development has been due, as most students of civic development will admit, much more to individual enterprise than to good guidance or good government. The basic reason for the rise of Montreal is the unique situation of the city itself, on one of the world's greatest waterways, at the head of ocean navigation, and yet hundreds of miles inland. It has thus become the main transfer point of all railroad and water borne traffic, inward and outward bound, of the larger part of a continent, and to this must be added its great natural advantage of abundance of water power, both present and potential, and its by no means to be lightly estimated steady and reliable labor market.

There is little to fear that the future growth of the city will be arrested or even in any degree lessened. Montreal will continue to grow, and it is this that brings us face to face with the question as to the manner of its growth.

Montreal was never designed for a really great city. It has simply happened along. If we consider it in its beginnings as an early settlement with rather narrow streets, we shall observe this little centre fringed around a series of long narrow strips of land, and we shall learn to appreciate the wisdom of the early French settlers who held the secret of sociable and neighborly farming, which is at the bottom of the successful agricultural development of the province of Quebec, and which is in striking contrast to the rule-of-thumb rectangular and sectional methods of the other more westerly provinces.

But the intrepid pioneers of these early days were not prophets, and who can blame them if they failed to foresee the wonderful destiny of the mighty city which, during the last two centuries, has sprung up on the banks of the St. Lawrence River under the shadow of Mount Royal?

But unfortunately for us, what is good for agricultural development is not so favorable for the convenient and orderly disposition of a great city. For the multiplicity of ownership entailed by these long narrow strips requires a strong and intelligent guiding and controlling hand in the laying out of streets, and that is what Montreal has never had, what she most needs, and what if she continues to do without will only bring her into more and deeper trouble.

Already Montreal is becoming cumbersome and unwieldy, her shoes are beginning to pinch, and she is, to use a colloquialism, "treading on her own feet." It is not to be expected that free, healthy and vigorous movement can be had under encumbrances like this, nor can we hope that this condition of things can by any possibility remedy itself. It is bound to become more and more aggravated as the city grows and traffic increases.

Street Congested with Traffic

If we have doubt in this matter we have only to note during the rush hours the enormous glut of traffic from tram-cars, automobiles, motor trucks, cabs and delivery wagons, backed up for a couple of blocks, with the poor pedestrian dodging for his life. Clearly the streets and crossings have not been designed and proportioned to accommodate and digest such an amount of traffic.

There is also the ponderous tram-car swinging round the corner to remind us that the Tramways Company holds sway, not only the roadway, but also the sidewalk itself.

And as car after car gradually works its way up to the crossing, each one freighted with a seething mass of concentrated humanity, and having its exterior decorated with

another contingent of quondam acrobats hanging on to the steps, after a free-for-all scrimmage between those who want to get off and those who want to get on, there is yet to be seen a goodly number of disappointed and disgruntled ones "left at the post."

It might be too optimistic to expect that even with proper and judicious town planning we should be able to eliminate the overcrowding of cars, but if we could succeed in stopping the overcrowding of streets and crossings we should then be in some sort of position to "talk" to the Tramways Company, and take away their only remaining valid excuse.

Common Sense Necessary

If we take a walk towards the down-town district, on the brow of the hill we see a horse struggling vainly trying to haul uphill a load about twice too heavy for it, sometimes shivering under the merciless lash of the driver. We shall notice that, if left to itself, and there is room for it, the horse will take a zigzag course, that is to say, instead of going full tilt up the face of the hill as the street has been laid out, it will seek an easier gradient in a diagonal direction. We are tempted to wonder what that poor dumb creature thinks, and what contemptuous expressions it would utter regarding the mentality of those responsible for its plight, and at the same time, we may begin to realize that town planning is not so much a matter of transcendental science or of art as it is of ordinary, every day, common horse sense.

As we reach the down-town district, perhaps the first thing we shall observe is that all the traffic is going in one direction. These are our "one way streets," not bad things in themselves as a merely temporary traffic exigency. They are, however, a self evident confession of incapacity and economic weakness and simple postponement of a better method.

Next we shall notice, lining the sidewalk, a long array of automobiles, laid wheel to wheel like batteries of guns, and we shall wonder what we are going to do ten years after this when the number will have multiplied manifold, unless perchance by that time the motor car will have been supplanted by the aeroplane and we may be able to get in and out of the upper windows without using the streets at all.

As we continue our journey further we come upon one of our public squares, where we might expect to see some grand old trees, fountains and monuments and we find that this too has been practically turned into an automobile parking stand.

We visit another, the historic spot where the founder of Montreal, Paul Chomedey de Maisonneuve, withstood the onslaught of the marauding Indians over two hundred years ago, and where his magnificent monument by Hebert is the dominant feature of the main Tramways transfer station, the marshalling ground of the noble army of strap-hangers.

I am sure if he could only see it to-day he would lay down his arms and take the first boat for France.

Nor is this all, for a little further on we reach another historic place where the tread of marching feet has echoed and re-echoed for generations, and there too we shall find the ubiquitous and all-conquering automobile occupying its section, while the remainder on certain days at least is made to serve as a huckstering market place all cluttered over with garbage.

Must Discover Solution of Difficulties

We are not for a moment trying to impugn the policy of our civic administrations in permitting these things. We perfectly realize that under existing circumstances they have been in a manner forced on them, and we are loath to believe they are more than mere temporary expedients. They are cited simply as an indication of "Breakers ahead!" and a warning that it is time to take our bearings and try to discover some more practical, fitting and permanent solution of the difficulties confronting us.

And as possibly we have stayed down town long enough to convince ourselves that from a traffic point of view at least everything is not as it should be, let us follow one of

*Paper read at the Town Planning Conference, Montreal, Sept. 29-Oct. 1, 1921.

the principal thoroughfares leading towards the upper town and there we shall find similar conditions of congestion, obstruction and delay. Indeed it is doubtful if in Montreal we can say we have a main thoroughfare worthy of the name. They are all too narrow, cribbed, cabined and confined.

But if we stray over into the bordering residential sections we shall find a different state of affairs, for there the streets are all too wide, just as wide, in fact, as our principal thoroughfares and there is really no necessity for this; it is both literally and figuratively throwing money in the gutter.

To be sure a great many people believe a street can't be wide enough, until they are asked to pay for the paving and for the maintenance and renewal. Possibly it will be said, "Oh well, it is the proprietor who pays for that," but don't you believe it, for it is with that as with other things, it all comes back to the ultimate consumer, and usually it is the working man that is the goat.

Character of Districts Change

And as we pave these residential streets just as we do the main ones, they at once invite heavy traffic and actually become through traffic streets. Then comes the corner grocery, the fancy goods store, the Chinaman, the tobacconist and the saloon; next the industrial flat, the shirt and collar factory, the cigar and paper box factory, with larger and heavier industries following in train. And one fine morning when you wake up you observe the men in the street digging up your beautiful pavement that you paid for in order to lay down heavier water pipes and larger sewers. And soon your rent, your taxes, and fire insurance premiums go up, and you begin to realize that all Montreal is on the move,—uptown.

The reason is that the factories down town have driven out all the respectable residents leaving a lot of tumble-down shacks that soon become infested with foreigners and the improvident, dens of misery squalor and vice, open cankerous sores, that eat into the body politic, and which are, one might say, about the most expensive and extravagant luxuries in which a city can indulge.

And it does not stay at that, for the factories soon find that the sources from which they have been drawing their labor supply is disappearing, and they start to get after it, invading the upper town districts, and leaving in their trail the slum areas they have created, and the large derelict tracts that we see of unoccupied and unproductive land.

This sort of thing is what is hailed by some people as the onward March of Progress, and it is fortunate for those keen-seeing and astute enough to be able to exploit and take advantage of the constantly fluctuating land values. It may even give the appearance of plenty of business and lots of work being done; but it is all lost motion, going round and round in a circle, putting up and pulling down, building and rebuilding, so much waste and nothing accomplished that is enduring or worth while.

A Comprehensive Plan Essential

How much better it would be if we would have a definite plan of development to work to, putting things in the places where they rightly belong and having them stay,—put.

That is to say, segregating industrial, business and residential property to the localities where each would be mutually advantageous and least detrimental to others.

Taking the factories, for instance, and all the industrial establishments and herding them together in districts close and convenient to the transportation systems, the railways, canals, and wharves, we could give them an economical concentration of ample water and sewerage services, power, lighting and heating facilities, special fire protection, and every accommodation and help they might require. This would improve their working conditions, reduce their production costs, eliminate a vast amount of unnecessary cartage, and to advantage all around.

In addition to this it would mean a wonderful saving to the city itself, for the heavy cartage would be guided

and directed along main thoroughfares proportioned and constructed to be able to provide relief to all the other streets which would not then be as they are now in a constant state of transition and upheaval through having new and larger water mains, sewers and power conduits put in. Fire risks would also be diminished and fire insurance premiums with them.

Even rent and taxes would be lower, for the occupation of the land and property speculators would be largely eliminated because land values would be stabilized, and undergo only a steady and gradual appreciation concomitant with the city's growth.

Besides benefiting the individual and the public generally, the city itself would soon be in a better financial position, and be able to provide automobile stands, transfer stations and market places without having to gobble up the public squares. They might be able to widen some of our main thoroughfares in a systematic way, or what is easier and just as serviceable, round off the corners of our most congested crossings, or better still provide circles introducing gyratory movement of traffic, thus lessening obstruction and minimizing the risk of accident.

Diagonal Thoroughfares

New main diagonal thoroughfares might be constructed at even less cost than street widening, for they could be designed to pass through least valuable property, and the enhanced value after construction might be sufficient to cover the entire outlay. These diagonals would be doing double duty of reducing the grades and shortening the distance, besides relieving the existing uptown and crosstown streets of their burdenn of traffic.

Many things like these and many other devices might be used to give much needed relief and work wonderful improvement if we could only make up our minds to go about it in a systematic and comprehensive way.

Perhaps it is not forgotten, and it should not be forgotten, that only a few years ago many millions of dollars were sunk by the city in useless expropriations and clumsy and abortive attempts at street widening. And the reason is not far to seek, for instead of making a thorough diagnosis of the condition of the patient and getting down to the roots of the disease, they were only administering palliatives and treating the mere symptoms as they appeared on the surface, while the disease itself was allowed to run unmolested, eating into our very vitals, which it still continues to do.

I sometimes think that town planning is like grasping a nettle, if you do it in a gingerly way it stings you, but if you take hold of it with grim determination it will be harmless and prove all to the good.

And of all the evils and bottomless sinkholes of perfectly good money, this piecemeal town planning, this tinkering, is the worst,—carrying out a bit of street widening here and street extension over there or suggesting a big boulevard somewhere else, most of such movements springing from more or less self-interested motives. It may be possible to effect a little improvement here and there but never in a way commensurate with the expense, and you are dead certain to get into greater trouble at some other point.

If this thing is to be tackled in a serious way with the expectation of arriving at anything worth while it must be by taking the city and surrounding district as a complete entity, studying its whole fabrique, and working on a general scheme of development from the bottom up. And if you asked me "what is the bottom?" I would say at once it is the Railroad Transportation Problem.

Should Co-operate with Railways

The railways are the one thing you can least juggle with, as some of our friends from Toronto may be able to tell us. And yet it may be possible to eliminate a certain amount of that needless duplication of rival surface lines and terminals which, at present, have such perilous and paralyzing effects. We can only do this, however, with the help and co-operation of the railway companies them-

selves, and fortunately for us, the day is past when the railways seemed to be run on the principle of "Ourselves alone and the People be Damned." The managements of today are intelligent and alive to the fact that what is in the best interest of the public is bound in the end to be to the advantage of the railways.

The railway transportation system and the street transportation system must be made to link up and dovetail in together so that each will be the useful and helpful adjunct of the other, instead of being, as now, often in serious and open conflict.

We must bear in mind that it is necessary not only to have main thoroughfares of ample capacity and reasonable grades but that it is necessary to have a street transportation or main arterial system.

Zones

Our factories and industrial establishments must not be strewn promiscuously all over the place, but arranged and located in an orderly and intelligent system.

Similarly also our shopping and business premises should be confined to certain streets and localities in some sort of system that will be most advantageous to themselves and least detrimental to others.

And in particular our dwellings and residences should be kept free of invasion from factories and business concerns, so as to keep down the rents and taxes and at the same time preserve that wholesome, sweet, clean and quiet reserve that is in keeping with the idea of home.

We need more parks and recreation grounds and especially a more equitable distribution of these in the localities where they are most needed, in fact a Park System, linked up by creditable tree shaded driveways or boulevards and not as at present to be approached only through mean squalid unbanked streets.

No doubt it will be said that while all this may sound very well in theory, it is quite another matter to work it out in practice. I quite agree with that, and I would like to say that our success will depend very much on how we go about it, if we ever attempt anything of the kind. Other great cities are trying it and effecting wonderful improvements with beneficial results. Indeed Montreal can only come in now at the tail end of the procession, for there is not a city of anything like its size and importance on the American continent that has not some scheme of development.

Comprehensive Plan Necessary

What is wanted is a general comprehensive plan as a clear objective towards which we can gradually work. The carrying out of the plans will not be the work of a day or a year or even five or ten years; perhaps few of us here would ever live to see its consummation. But we need to make a start in the right direction and along proper lines and not be, as we are now, a ship at sea without a chart or compass and without even a man on the lookout, drifting, drifting,—“We don't know where we're going but we're on the way.”

Another objection likely to be raised is that we are starting in to interfere with individual interests and the rights of private property, and my answer is, it is about time we did, for they have been interfering with and overriding us long enough. If there is one thing more than another that has brought us into this mess it is the assertion and exercise of individual privilege over public interest and the common good, the only remaining thing left to the public being the privilege of paying for it all, with little or no voice in the matter. But town planning is in the interest of all and ultimately for the best interest of every single individual.

Again, it will be said, “It is too late, we have gone too far, at least as regards the built up portion of the city.” That is to say that Montreal is in the position of the small boy with his catechism lesson. He had got past “redemption” and was beginning to “endure the pains of hell forever.” Well, I am not one of those who believe that; and

in any case, how is it we are so apathetic regarding the unbuilt portion of the city? We recognize that things are bad in the centre, and we are doing precisely the same thing on the outside, only we are doing it worse than has ever been done before, and we are doing it over a much greater area. For if we look out there among the stubble, and carefully examine the surveyors' stakes we shall find a bountiful crop of expropriations for street widenings, extensions, and adjustments growing up, under the burden of which unless corrected in time the city of Montreal will go staggering for generations.

Embryo Slums

We talk, too, about hygienic measures for the prevention of disease and the uprooting of slum conditions while we are making them with the one hand faster than we can unmake them with the other. By the way I was cautioned above everything not to say that Montreal had such a thing as ‘slums,’ and I am not going to say that it has, but I will say that out there in what is now nothing but pretty green fields you can find slumdom in embryo, lots of disjointed, broken backed, dead end streets, which, cut off from the general circulatory movement, must in time become the refuge of the foreigner, the nestling and breeding place of dirt and disease, and the hotbed of the epidemic.

Economy of Planning

But perhaps the last and seemingly insuperable objection is certain to be raised, it is this: “The city of Montreal has no money for town planning, there are many more important and pressing things to be attended to before that, so there's an end to it.” I confess that somewhat floors me, but I am tempted to ask, as many another has done before me, why a prosperous and wealthy city like Montreal has no money. I know of course there have been numberless allegations about graft, mismanagement, and so forth. Now, I don't know anything about that and am not going to say anything about it, but this I do know and will make the statement without equivocation, that the main reason why the city of Montreal has a deficit today is because all the city governments we have ever had have been too busy working on the surface, tackling results, and have never been able to get down to first causes. Even the best intentioned of them have been valiantly trying to stop the waste by holding their hands over the burst pipe without stopping the flow of water at its source. And I will further say that if the city of Montreal can't afford to get a systematic plan of development, it is mainly because hitherto it has not had such a plan. And until it gets one, an good and well considered one at that, the city will keep on leading the hand-to-mouth existence it has been doing, and that condition will steadily continue to get worse instead of better, no matter what we do.

Before closing I would like to say a word or two regarding the embellishment of Montreal, about which a good deal has lately been spoken. Candidly, I have no liking for the world, it savors in my mind entirely too much of artificiality, and in any case is beginning at the wrong end. If we can plan wisely and well on useful, economical, orderly and symmetrical lines, the city will naturally embellish itself.

But what worries me is that we have already been going in for that sort of thing, laying out parks and squares in the conventional Union Jack pattern and planting rows of trees spaced with dull and deadly regularity, on isolated patches of ground that are as bare and bald as a pole-cat, while our eyes have been blind to the real beauty spots we already possess, with magnificent outlooks over the river, and with noble majestic trees, the growth of a century. On the trunks of some of them you will see big notice boards nailed, with the inscription “Fine Factory Sites for Sale.” Now if we were careful to conserve some of these before they are racked and ruined, we should be doing more for the embellishment of the city than we could do in fifty years of artificial work.

In passing, let me put in a plea for "Our Friends, the Trees." It is not so many years since Montreal used to be called the "Forest City," but I don't think anybody would care to call it that to-day. The ravages of insects, the natural process of decay, the clumsy butchery of the electric lineman, and the curiously mistaken notion that trees have no place in a business section, have all got in their deadly work, and the city is fast becoming bare. Now if we have any notion of going in for the "City Beautiful," and I would like to add the "City Sensible," we can't do better than emulate the example of other cities who are spending a lot of money to save the trees they have, and plant as many new ones as they can.

In conclusion would it not be well if we could hold up before our eyes some sort of ideal towards the consummation of which we could steadily strive to attain. I believe there is a certain big city at the head of the lakes which has already appropriated one, it is to be called the Paris of the American continent. From one of the dingiest and worst planned cities it has made great strides in recent years, and by voluntarily taxing itself for the carrying out of wonderful improvements under its famous plan of development, it has been doing its utmost to deserve that appellation. In this sort of thing, however, it is not so much a question of "Who saw it first?" as it is of who can make good its claim to the title. And surely the second French city in the world to-day is not willing to stand idly by with folded arms while the guerdon goes past it. If we can only make up our minds to begin, we have within us all the elements of success. With the fine artistic sense of the French as already exemplified in the works of Hebert, Laliberte, Suzor-Cote and many others, together with the inimitable instinct of that race in seizing hold of the joy of living, and getting the most and the best out of life; and the energy, enterprise and sterling business qualities of the English speaking nationalities—with these blending and operating in unison what is there to stand in our way?

This then I commend to you as the goal we should strive for, and which we may ultimately reach:—"Montreal le Paris de l'Amerique."

GOOD ROADS ASSOCIATION MAKES PROGRESS*

Review of Work of Ontario Association Since Organization
— Work Being Efficiently Done — More Interest
Being Taken in Township Roads

By T. J. Mahoney,

President, Ontario Good Roads Association

IT CAN safely be said that the progress and the sentiment in favor of road improvement in the Province of Ontario has been parallel with the progress of the Ontario Good Roads Association. The Association was organized in 1894, and in 1896 we had a provincial road instructor appointed whose object was to make uniform the building and construction of our highways. In 1902, the Highway Improvement Act as passed, under which the Province of Ontario laid aside \$1,000,000 for the improvement of county roads in the province, on the basis of 33% for construction purposes. In 1912, there were \$5,000,000 set aside for the construction of colonization roads in the northern part of the province. In 1913, the Highway Commission was appointed whose purpose it was to investigate road construction and road financing, not only in this country but in other countries as well, and it is largely on the excellent reports which that Commission submitted that our present highway construction and highway financing is to a large extent based. In 1915, legislation was brought in which provided for the establishment of provincial county roads under which the government proportion was increased on those roads to 60% instead of 40%.

*Presidential address before Ontario Good Roads Association Convention, Toronto, March 1.

In 1917, the Provincial Highways Act was passed, and it is not necessary to refer to the great increase which has been made in the highway legislation and road improvement since that Act was placed on the statute books. I think you will agree that we have reached a stage where public sentiment has advanced so far that plenty of money will be available for road improvement, providing the people are satisfied that that money is spent economically and to the best possible advantage.

Well Balanced System of Roads

We have in this province a very well balanced system of roads. We have our provincial highways which are under the direct supervision of the Government, which are financed and constructed by the Highway Department. Of these roads we have 1,800 miles connecting the main centres of our province, and they are intended to carry the bulk of the through traffic. We have close to our urban centres provision made for suburban roads to which the cities or towns and the counties will contribute a share, and they are also assisted by a percentage from the Government. Then we have our ordinary county roads on which the Government pays 40%, and last but not least, we have our township roads which, so far as mileage is concerned, are the most important divisions of our roads in this province.

It is not necessary to refer to any extent to the provincial highways. The efficient corps of engineers which the government has constructing these highways is good evidence that the work on these roads is being done efficiently and well. So far as the counties are concerned, they have for the most part been engaged in highway construction since 1902, and they have had a great deal of experience in road organization and road construction, and we can safely assume that in most of the counties of this province, our county road work is being done efficiently and economically.

Township Roads

When we come to township roads, there is no question that this important link in our system has to some extent been overlooked in the past. It was only two years ago that legislation was placed on the statute books whereby the province was to contribute 20% on the work done on these roads provided it was done under certain regulations. Since that subsidy has been granted, there has been a greater interest taken in the work on our township roads. Your executive realizing the importance of greater interest in connection with the township road work, has devoted one complete session to the consideration of township road matters, both as regards construction and road accounting and financing. "Who should pay on Provincial Highways" is an interesting subject for discussion and it is a subject on which the people in this province who are beginning to feel the effects of the tax will be interested.

The Ontario Good Roads Association has been during the years it has been established, as it were, a leader and an educator of public sentiment with regard to road matters, and while the final say with regard to legislation rests with the Government and the Highway Department, I think it can be truthfully said that the expression of opinion given at this convention and through the members of this association will not fall on deaf ears.

That American cities are making tremendous strides in street paving is indicated in reports from city engineers to The Asphalt Association, which show that over 270,000,000 square feet, or 1750 miles, of asphaltic pavement, thirty feet wide, will be laid on city streets this year. Reports from State Highway Departments indicate that 207,000,000 square feet will be laid on the State highways, while the area laid in counties and other districts will bring the total to 585,000,000 square feet, or 3690 miles, of asphalt pavements, thirty feet wide. This will be an increase of 35 per cent over the area paved in 1920, and is sufficient to build an asphalt road thirty feet wide from Augusta, Ma., to San Francisco, Cal.

GOOD ROADS SYSTEM IN ONTARIO*

Assistance to County Roads Under Highway Improvement Act — Government's Subsidies for County Roads — Type of Road Giving Satisfactory Results

By Hon. F. C. Biggs,

Ontario Minister of Highways and Public Works

AS ONE travels from place to place and interchanges ideas with municipal officers, it seems that everyone wants better roads, but the big difficulty confronting that idea is impatience on the one hand and lack of funds on the other. It is impossible to build roads everywhere all at once, and so it is up to the officials in the counties and the townships to single out the roads that will do the most good and build them first. And as you build them do not lose sight of the fact that within the last five years the motor cars of this province have increased from about 40,000 to over 200,000.

The convention this year is probably the most important up-to-date on account of the many townships that have adopted the good roads plans, appointing superintendents and enlarging their scope and interests in road work. Another reason why it should be the most important is the fact that the counties are spending more money on roads than ever before in the history of the province. With these large expenditures it is well for the officials of the counties and townships to keep in close touch with the very latest ideas that may be carried out in the different municipalities and on the Department Highways.

At the present time, the Province of Ontario and the world in general is suffering under a heavy depression. During the war period, prices became inflated and we based too many of our calculations on those conditions. Now prices on agricultural products have gone back to practically pre-war levels, and a great responsibility rests on the shoulders of the municipal officers in the counties and townships, for while the prices were gradually increasing, there was only one thing to do as far as materials and wages were concerned, and that was to buy at the best price, but at the present time materials are coming down, and municipalities must use their best judgment as to the proper time to buy. But probably the most important factor is the factor of wages. Wages went up on account of the scarcity of help, but today in the Province of Ontario we have a great unemployment situation. While we want to do the work as reasonably cheap as we can, we do not want to persecute those whom we employ; we want to use them at least fairly at these times until the necessities of life reach a normal level again.

Adequate Drainage Essential

I want to say a few words in regard to road expenditure, the mileage undertaken and the way the townships are taking hold of the work. The one great essential in the development of roads is not the surface that is put on the road, but the drainage. We have thousands of miles of gravel road in the Province of Ontario today that is going to pass through the fall and spring seasons of the year in poor condition on account of inadequate drainage, and when we put down the higher type of road, we never think of leaving it until it is properly drained in every respect. Is it not just as important that the gravel and macadam road should be properly drained and maintained, as the better classes of roads? We have thousands of miles of gravel roads in the province that would give twice the wear with half the maintenance if the drainage was properly looked after. The one great essential to my mind in road building in the province today is the drainage of the road.

During this last year a new way of carrying out county construction was undertaken in several municipalities. I

might mention two cases: one is in a rural district and the other in a suburban district. The first one is in Halton County, directly north of Oakville on the line running north to Georgetown. On this road which is situated in a heavy clay country, a concrete strip 9 ft. wide has been put down, with 3 ft. stone shoulders on the sides. This seems to answer the need there very much more rapidly and very much more economically than if that county had stopped to build the full width of roadway. That road carries a medium traffic, and undoubtedly a very large percentage of that traffic can be handled on the concrete strip, and the stone shoulders will only have to take the turnouts. I have had reports given to me that at least 98% of all the travel over that road will be on the concrete. We have the Township of Trafalgar, without any road material at all, into which every bit of stone or gravel to build a road had to be shipped, and if the county had waited to build the full 18-ft. road there would have been only half the stretch served by a permanent road as is served today, with the same expenditure. It seems to me that at the present time many roads could be well served with that type of construction.

Then just out of Brantford on the Burford road, in the suburban district, the county engineer has put down another 9-ft. strip, but this time the road is all on one side with the idea that later on another strip will be added giving the full width of road. Gravel has been placed on the side that is not paved. That strip is carrying a large percentage of the traffic, and if the Suburban Commission had waited to extend the road out the entire distance, only half the distance would have been served.

When the Toronto-Hamilton Highway was promoted, there was a difference of opinion as to the route that should be taken, and so from King's Junction down to Freeman, we have a 9-ft. strip of road partly in Wentworth and partly in Halton; it has stone shoulders and has been down some years now, and the cracks in the slabs are not nearly as numerous as where the road is wider, and this strip seems to be giving the public splendid satisfaction and serving the purpose fully for which it was intended.

Assistance Under Highway Act

This last year we have been able to co-operate with several counties in assisting the towns and villages with county and provincial-county roads in having the connecting links brought into shape. Last year it was the policy of the Department in the amendment passed to the Highway Improvement Act of 1920, to pay back to any county the money granted to town or village or provincial-county roads of 40 or 60 per cent that the county makes to that connecting link. Having watched the building of county roads for some years, I have found that very often the weakest link in the county road is in the town and village. These towns and villages have contributed, without any grant from the county, on the same assessment rate on the equalized taxation as the townships, and until last year no subsidies were paid back on the connecting links. We find this is bearing splendid fruit. Kent County has taken hold of it splendidly, and several other counties, and I am sure it will bring good results, but the one outstanding feature in road development this past year has been the progress that has been made in township roads. A great many of the townships in the province have taken advantage of this assistance, and I have some figures that may be of interest to you in this connection. Out of 376 townships eligible for the aid, 299 have passed the necessary by-laws in 1921 and will receive their 20% on their road expenditure in their townships; out of 299, 152 have appointed township superintendents on whose salaries they will receive 40% assistance.

This is a new line of assistance on roads, a line of assistance which I think is very worthy in its motive, because I think you will agree that per mile of road, the township road has fewer taxpayers to pay towards it or look after it than any other road in the Province of Ontario, and while we may have developed fairly good pro-

*Address before Ontario Good Roads Association Convention, Toronto, March 1.

vincial roads and good county roads, still the great essential is that people on the townships roads should have a road to get to these trunk lines. I believe this assistance is going to do for these roads the very thing we need to add stimulus and give some enthusiasm to township councils in carrying out that work. Of course this will not be felt to the full degree until we get the township returns in for 1921, as most of the townships came in during 1921. As soon as these returns are in, to any township that has spent \$5,000 on road improvements and bridges, we will send them back a cheque for \$1,000; then that cheque coming in after the rate has been struck for the townships, and it adds an extra \$1,000 or \$2,000, as the case may be, it should do a great deal towards raising the standard of the township roads.

Review of County Road Work

I will give you a short history of the county road work. The Highway Improvement Act was passed in 1902, just twenty years ago this season, the first county came into the Good Roads System. It took from 1902 to 1918 to get the 37 counties in the Province of Ontario to enter the system. The County of Wentworth was the first county to come under the Highway Improvement Act; Simcoe and Lanark followed quickly along late in 1902 or early in 1903. Then the counties gradually came along until 1918, the County of Peterboro came in, in part, and now the whole 37 counties are in under the Highway Improvement Act. Since the beginning of 1919 the county mileages have not increased to any appreciable extent, because approximately 1,800 miles of provincial road were taken from the county mileage.

Grants to County Roads

It is interesting to follow the figures in connection with the grants. In 1903 the government subsidy to county roads was \$55,383; 1904, \$97,000; 1905, \$59,000; 1906, \$82,000; 1907, \$127,000; 1908, \$147,000; 1909, \$146,000. Then we jump to 1917, when it was \$475,000; 1918, \$815,000; 1919, \$2,623,000; 1920, \$3,626,000; 1921, \$4,750,000 approximately. You will notice that the greatest yearly increase has been from 1918 to 1919; then there has been a considerable increase the last two years, until we have over \$4,500,000 subsidy paid back to the counties, with a total expenditure in the counties of about \$10,000,000.

The county councils are the elected representatives of the people and they have to go back to their electors, the taxpayers, once every twelve months for endorsement of their position. If this increase the last three years speaks the voice of the people, as it must, then public sentiment in roads in the Province of Ontario, as demonstrated through their yearly elected representatives, is greatly on the increase.

This opens up a big field as to whether we are going too fast or not. That is a matter for you as municipal representatives to decide when you weigh up your local conditions. Personally I do not think the roads are being built too fast in proportion to the increase in motor traffic. The success of this country entirely hinges on the success of the rural people, and if we want the rural people to forge forward so that we will be able to meet the debts of this Dominion of Canada, will an investment in roads retard or aid them? To my mind, an investment in roads, if we want to pay our war debts and make rural life comfortable and profitable, is the best investment we as citizens of Ontario can make. I have ceased to speak about expenditure in good roads; I claim it is an investment, and the highest type of investment.

We have in this province, counties that have been in the good roads system for 18 and 20 years, gradually adding to their mileage; we have other counties who have been in for ten or twelve years working steadily along, and then we have counties who have come in within the last three or four years and who are trying to overtake the other fellow, who has been at it for ten or fifteen years.

We are trying to develop the provincial roads as uniformly as possible over the province, and with the 1,800 miles we now have, and when these roads are developed, over 90% of all the population of old Ontario will be served, and the many, many miles of county roads and township roads which are now being worn out as fast or faster than the municipal officers can build them, will be relieved of a large share of their traffic, and the expense to the municipalities will be much lighter on these roads.

NEW HIGHWAYS ACT FOR ALBERTA

THE proposed new highways act for the Province of Alberta provides for an appointive highway commissioner and a good roads board. The board is to be composed of the deputy minister, the highway commissioner, and three other members to be appointed by the lieutenant-governor in council.

The commissioner is to be the chairman, and three members shall form a quorum; salaries of the board to be fixed by the executive council. This board is to have complete control over all highways in the province to determine classification, suitable methods of construction and maintenance, recommend allocation of money to be spent on them voted by legislature, and to make all rules governing the roads, including speed and equipment of vehicles.

Highways are to be classified as main highways, market roads, local roads, colonization roads. The main highways are to be trunk channels of communication between cities and towns or with main travelled roads, and entire cost of construction and maintenance is to be defrayed by the province.

Market roads are to be roads of less general importance, but of outstanding local importance in the market of produce in the area where the road runs. Entire cost to be borne by local authority of area where road runs, but provincial contributions may consist of amounts to that percentage of the cost of the work set out in a schedule as follows:

Clearing, grubbing, ditching, construction of timber culverts and bridges, grading and such other work necessary to provide earth roads, 33 1/3 per cent.

Road surfaces of sand, gravel or clay, 50 per cent.; constructing concrete culverts, 66 2/3 per cent.; constructing steel or concrete bridges costing more than \$2,000, 66 2/3 per cent.; constructing steel or concrete bridges costing more than \$2,000 and not more than \$10,000, 75 per cent.; constructing steel or concrete bridges costing over \$10,000, 100 per cent.

Local roads are to be all those not classified as main highways or market roads, construction and maintenance to be paid for by local authorities in the area in which the road runs.

Colonization roads shall be such roads as may be temporarily established for development of newly settled districts "or for other good reasons." Their construction and maintenance shall be paid by the department.

Windsor, Ont., has more concrete pavements in respect to its size than any other city in America, according to a statement by W. A. McLean, deputy minister of highways, before the Ontario Good Roads convention. Not only that, said Mr. McLean, but it has the oldest concrete pavements of any city. M. E. Brian, city engineer of Windsor, stated that Windsor has a total area of one and one-quarter million square yards of concrete on its streets. Last year every crack in these pavements was tarred, and this year the city will execute a still larger program of improvements. Those streets which have not been paved for 15 years are "pretty well shot" now, he said; but, in consideration of the fact that the pavements were laid at a cost of \$1.01 1/4 per yard, they have served well. It has cost the city 45 cents a yard to maintain them.

MAINTENANCE OF GRAVEL ROADS*

Importance of Adequate Drainage in Road Maintenance — Stable Foundation Essential — How and When to Use a Drag — Laying Gravel and Rolling

By D. J. Kean,

Superintendent of Highways for Ontario County.

TWO OF the most important points to be considered in the construction or maintenance of a road are drainage and foundations. It does not matter whether the surface be earth, gravel, macadam or concrete, its life depends on a stable foundation. The stability of the foundation depends on adequate drainage, for a subsoil saturated with water cannot furnish a good foundation. We employ three methods of drainage for our roads. To drain the surface of the roadways we give them sufficient crown to shed the water into the side ditches which are provided to carry the surface water to a free outlet. Under-drainage is used to lower the water level in the soil and keep it at a safe distance from the foundation and also to centralize the location and direction.

Under-Drainage

Under-drainage intercepts the flow of sub-surface water beneath the crust of the road. In this way the ground dries quickly in the Spring avoiding a soft and spongy road that would soon become a mass of mud. A road on a wet undrained bottom will always be troublesome and expensive to maintain, and when you consider the expense the municipalities having jurisdiction over these undrained sections of road are confronted with each Spring, and the inconvenience the travelling public are subjected to, tile under-drainage and proper side ditches are surely beneficial and economical. It is therefore economy in the long run to go to considerable expense in making the drainage of the sub-soil as perfect as possible.

Particular attention should be given to under-drainage at points 50 to 200 ft. or more down grade from the top of a hill, and particularly so if the roadway is in an excavation also a sidehill cut. Water will filter out to the surface at such points and the entire skill of the road builder will have to be exercised to prevent the road heaving and breaking up into a mire in spring time. In such cases put in ample tile, do not curtail the under drainage, but care must be exercised to provide a proper grade and a good outlet for the tile otherwise poor results will be obtained if the tile is indifferently laid. Sometimes a blind drain may be used to good advantage.

Side ditches and a proper crown are essential to all country roads, the object of the side ditches being to drain the water from the travelled roadway. The grade of the ditch should be such that the water is carried rapidly to a good outlet.

Surface drainage of the travelled portion of the road is accomplished by giving it a crown, the proper crown will vary with the nature of the roadway. For earth or gravel roads a usual crown is from $\frac{1}{2}$ in. or 1 in. to a foot. It is not good policy to have too much of a crown, for then the traffic is concentrated in centre whereas we wish to distribute the traffic over the whole of the travelled portion of the road.

Methods of Maintenance

When the gravel road requires dragging at frequent intervals, it may be due to the gravel becoming worn out, having very little metal left in it, at the same time being subjected to unusually heavy traffic or to extremes of wet or dry weather. It is good economy to spread a thin layer, according to the condition of road and traffic requirements, of fine pit or cementitious gravel over the surface and rolling it if a roller be available. If not the traffic will compact it by reason of the fineness of the materials and the thinness of the layer.

Two principles are involved in the use of the drag. The first is the length and position of the hitch, and the second is the position of the driver on the drag. For ordinary purposes fasten the clevis on the chain at such a point so that the drag unloaded will follow the team at an angle of 45 deg. In this position the earth moves freely along the drag, and the draft on the team is light, if the driver rides in the line of the draft. Sometimes conditions are met with that require special treatment but for the most part road working with this implement is very simple. The object of such treatment is to move the material from the side toward the centre of the roadway, to fill the holes and ruts and to raise the centre gradually above the surface at the sides; there will generally be found considerable good material at sides of road which has been crowded out by traffic. This material if not dragged in toward the centre of the road will soon accumulate and prevent water from escaping to ditches. The traffic then will solidify the fresh material in the ruts and holes. Another implement by the use of which very satisfactory results can be obtained is the one-man-one-team grader. This in many cases is superior to the split-log or steel drag for levelling, but both implements serve a good purpose when in the hands of a competent operator.

When to Use the Drag

The drag does its best work when the soil is moist but not sticky, the material then moves freely along the blade. If the roadway is badly rutted and full of holes, it is best to use the blade grader at least once. This is particularly true in the Spring just as the frost is going out. A smooth road surface is secured by this method.

Bring the road to a suitable grade and cross section and provide ample side ditches and if sub-surface drainage is required, put it in.

The gravel is dumped on the road in such quantity that it will spread to the thickness desired and then spread with shovels or by light blade grader, which saves time and money and does better work than by hand.

A thin layer, 3 to 5 in. thick, has proven economical. It quickly consolidates and gives smooth surface. A drag is very useful for maintaining the surface during this period and if the dragging is done carefully after the rains, a smooth even durable surface will result.

Pit gravel falls into four groups: (1) Ideal gravel. (2) too coarse, (3) too fine, (4) lacking in bonding material. The bonding property of gravel is due to clay, iron oxide, lime and the angular shape of gravel; the clay should not exceed 20%. Gravel should be well graded from a size that will pass a 2-in. screen down to fine clay, no more than 80% nor less than 60% should pass a $1\frac{1}{2}$ -in. screen.

Roller and Scarifier

Good economical maintenance can be accomplished by using a scarifier and roller. The gravelled portion of the road is scarified to a depth not to exceed 3 to 4 in. Even this depth will on the ordinary country road dig up considerable stones of a rounded shape, it is not advisable to rake or throw these off, but better policy to have at least 2 men follow the scarifier with light tapping hammers weighing about 2 or 2½ lbs., with long springy handles. These stones are made angular in shape by breaking and when again covered with gravel and silt, they will work in to the road and bond better with the other material on the road, and not so liable to shoot sideways when subjected to the pressure of the traffic as they did formerly. After the stones have been broken, the road is reshaped with a light grader and rolled.

This method of maintenance will average $1\frac{1}{2}$ miles a day and cost approximately \$25 to \$30 depending on length of haul of water and coal. A gravel road requires intelligent maintenance, but if given this it gives us a road surface that is comfortable to travel, affords good traction and is easily maintained under normal conditions. It is cheap to construct and will furnish the material for our road surface, for 75% of our roads for many years to come.

*Paper read at Twentieth Annual Meeting of the Ontario Good Roads Association, Toronto, March 2.

Engineer's Library

REVISION OF AN IMPORTANT WORK ON MILL BUILDINGS

Reviewed by C. R. Young,

Associate Professor of Structural Engineering, University of Toronto.

DESIGN OF STEEL MILL BUILDINGS AND THE CALCULATION OF THE STRESSES IN FRAMED STRUCTURES—By Milo S. Ketchum, Director of the Department of Civil Engineering and Professor of Civil Engineering, University of Pennsylvania; sometime Dean of the College of Engineering and Professor of Civil Engineering, University of Colorado; Consulting Engineer. Fourth Edition rewritten; New York: McGraw-Hill Book Co., Inc.; Flexible imitation leather; 6 by 9 in.; pp. 632; Illustrated; \$6.00; plus exchange.

Professor Ketchum's works on structural engineering have been for so long regarded as authoritative treatises that any extension or revision is regarded by those engaged in structural work as a matter of considerable importance. The present work in its earlier editions has had a most gratifying reception, constituting, as it does, the most generally useful work in English on the subject of mill buildings. In the fourth edition the book has been rewritten and enlarged from 556 to 632 pages with the type reset, the plates recast and large numbers of the cuts remade.

Important extensions in the subject matter have been made in this edition. Its scope has been enlarged by the inclusion of a concise discussion of the calculation of stresses in statically-indeterminate trusses and frames, by several problems in framed structures, by detailed designs of a crane girder, a roof truss, and a steel frame mill building. The whole work has been rearranged in logical order, based on the inclusion of the new material.

In the present edition the many problems relating to stresses in bridge trusses have been retained, although it is somewhat illogical to include discussions of this sort in a work on steel mill buildings. The purchaser of such a book is not looking for such matter in a treatise on mill buildings and it would undoubtedly be more logical for the author to replace this material by corresponding material relating to buildings and use the bridge matter in his other works where a discussion of bridges is naturally to be expected.

A valuable extension of the matter on influence diagrams contained in the third edition has been made in the present edition. The stresses in transverse bents are discussed at further length and the addition of a short consideration of the stresses in mill building columns due to crane loads is welcome. In chapter 12, which is devoted to combined and eccentric stresses, new and valuable matter is included on the properties of sections and on the oblique loading of beams. Much new matter is also contained in chapter 14 on area moments and curved influence lines. The discussion of deflections of framed structures in chapter 15 is specially good, although it savors perhaps too much of a bridge treatise for a work on mill buildings. The large amount of new matter on stresses in statically-indeterminate structures contained in chapters 16 to 18, inclusive, is presented in Professor Ketchum's well-known clear and concise style and constitutes a valuable short contribution to the subject. Secondary stresses discussed in chapter 19 are also appropriately included. A good deal of value is added to the work in the present edition through the extension of practical examples, such as the computation of stresses in a statically-indeterminate head frame and in other similar structures, the design of a steel roof truss with a detail drawing, the design of a plate girder for a crane runway and the complete design of a steel mill building with details. In an appendix a revised edition of Professor Ketchum's general specifications for steel frame buildings is included.

For the convenience of those using the author's works it is suggested that greater amplification of the index should be followed in future editions. Thus, for example, if one wishes to find out where a particular aspect of the subject of bracing is discussed, it is necessary to turn from the index to eight different pages in the work in order to discover the particular reference desired. It is believed that the addition of a few more pages making possible the greater sub-division in the index would be welcomed by busy designers.

Considered in a broad way it must be said that the present edition is a most valuable and necessary working volume for the design of mill buildings.

THE ARCHITECTS' AND BUILDERS' HAND BOOK: DATA FOR ARCHITECTS, STRUCTURAL ENGINEERS, CONTRACTORS AND DRAFTSMEN—By the late Frank E. Kidder, and a staff of specialists, with Thomas Nolan, Professor of Architectural Construction, University of Pennsylvania, as Editor-in-Chief. Seventeenth Edition, Enlarged; New York: John Wiley & Sons, Inc. Flexible imitation leather; 4¼ by 7 in.; pp. 1907; Illustrated; \$7.00 net.

In the enlarged seventeenth edition this well known handbook has been made still more valuable for architects, engineers, contractors and draftsmen. The work has been revised, several chapters rewritten, new chapters added, a new index made and many cuts re-engraved.

Most of the extensions have been made in Part II, which is devoted to Strength of Materials and Stability of Structures. Chapter XXX, by Robins Fleming of the American Bridge Co., on Specifications for the Structural Steel Work of Buildings is new. In this chapter a reasonable and thoroughly reliable specification based on the long experience of the author is presented. Chapter XXXI, on Domic and Vaulted Structures, by Edward F. Ries gives a clear presentation of a most difficult subject, including discussion of Smooth-Shell Domes, Ribbed Domes, Barrel Vaults, Groined Vaults, and Ribbed Vaults. Chapters XXIII and XXIV on Fireproofing of Buildings and on Reinforced Concrete Construction, respectively, have been rewritten by the author, Rudolph P. Miller. The material in these chapters has been brought up-to-date and in line with revised specifications and developments in the art.

In Part III which gives useful information for architects, builders and superintendents, the sections on Heating and Ventilation and Chimney construction have been entirely rewritten by Louis A. Harding.

In addition to the entirely new chapters, very many articles have been added to the text and new illustrations made, this including such matters as New Data on Building Laws Relating to Loads on Masonry; Graphical Method of Determining the Centre of Gravity of Plane Figures or Sections; Graphical Method of Determining Moments of Inertia of Plane Figures; Triangular Loading; End Connections of Tension-Members; New Wire Data; New Matter on Gauges; New Matter on Chains; Graphical Method of Determining the Deflection of Beams; Secondary Stresses; Angles Used as Beams; Data on Girderless Reinforced-Concrete Floors; Data on Tanks, and on Stresses in Cylindrical Tanks, etc.

In its present form the Kidder-Nolan handbook is a most valuable work of reference for those having to do with building construction. The various chapters and sections dealing with engineering matters have been prepared by specialists of very high standing, and the reader may rely on the accuracy and authority of the matter presented. No structural library is complete without a copy of this handbook.

The Carter-Halls-Aldinger Co., of Winnipeg, has now opened offices in Edmonton, from which they will handle roadwork, drainage and irrigation, railway work and building construction throughout the province of Alberta. John C. Weston is the manager of the Edmonton branch, which has established offices at number 430 Tegner building.

Letters to the Editor

CORRECTIONS

Sir: Will you please note the following errors which have occurred in the printing of my letter on the subject of "Libraries for Research Workers," which appeared in your issue of March 7, due, no doubt, to the conditions under which you are working during the printers' strike:

Fifth paragraph first line, for "together independently" read "altogether independently." Fifth line, for "of the great advantage," etc., read "to the great advantage," etc.

In the list of advantages given lower down in Clause (e), for "understood" read "undertaken."

The clause which you have designated "g" should be clause "f," and clause "g" does not exist in the original of my letter to you. On the third line of this clause "f," for "of firm," read "or firm."

I shall be glad if you will kindly correct these errors in your next issue, as they make my letter to appear a trifle lame.

A. S. L. BARNES.

Toronto, Ont., March 9, 1922.

ST. LAWRENCE WATERWAY

Sir: In your editorial of January 31, re "Rival St. Lawrence Waterway Projects," certain mis-statements are repeated from the report of the Hydro-Electric Power Commission of Ontario.

In the third paragraph of the above mentioned editorial, it is stated that "an advantage of the Hydro scheme 'B', as against a single-stage scheme such as 'A', or that proposed by the government engineers, is, as stated by the proposers, a reduction of the area flooded from 29,000 to 6,000 acres." This is incorrect, as the scheme proposed by Messrs. Wooten and Bowden, at the highest emergency level, only inundates 2,960 acres above the Ogden Island dam, only 8,900 acres between the Ogden Island and the Barnhart Island power houses, and only 400 acres from Barnhart Island to Cornwall. It is true that some provision is made for a future change in project, but this change is not part of the recommended scheme. Even if the maximum level of Lake Ontario were carried to the Barnhart Island plants, without any Ogden Island dam intervening, as advised by General Beach, Chief of the U. S. Corps of Engineers, the total area flooded would only be 22,000 acres.

You also state that the Hydro have used higher unit prices inside cofferdams than the government engineers have used. No unit prices are given in their report, and though questioned at the public hearing in Ottawa re this matter, the Hydro officers displayed no knowledge of higher prices for excavation being used.

In your editorial, you draw attention to the fact that differences in estimated costs are to be expected in preliminary investigations, but it must also be noted that some expected differences are not found in the estimates shown in the Hydro report. For instance, when the height of the walls and lift of the lock above Morrisburg are increased by 20 ft., a large difference in cost would be expected, but it is not found. When the head of water retained by a power house at Barnhart Island is double that at Ogden Island, an increase in width of base would be expected, but no increase is shown in the plans filed with the Hydro report.

The plans and written report of the Hydro are in definite disagreement with regard to the position of power houses at Barnhart Island, the number of ice sluices to be installed, and the channel through the Long Sault Rapids. Though the Hydro gives no quantities, and though their estimates cannot be related to either plans or report, yet an error of \$3,000,000 is evident in tail race excavation at Barnhart Island alone. These obvious errors have all been

found on the side which reduced the cost of their scheme "B" and enlarged the cost of "A".

Since the government engineers have replied to the Hydro criticisms, the Hydro have withdrawn their regulation of Lake Ontario, and as much of their report was based on the supposed results of this regulation, there is little of a constructive nature left in their report to discuss.

Your repetition of the Hydro statement, that during an average winter there will be 9.2 square miles of open water between Prescott and Barnhart Island, 2.2 miles of which is said to be between Morrisburg and Barnhart Island, cannot be supported, at least with respect to that below Morrisburg.

Above Morrisburg, in winter weather, the swift water flowing through the Galop Rapids, and through the islands above Brockville, will always chill the water to the freezing point, and with low velocity, it will readily freeze over, as it now does on Lake St. Peter, Lake St. Louis and Lake St. Francis. The average velocity from Morrisburg to the Long Sault, under winter conditions, will be slightly less than it is now through Lake St. Francis, or from Maisonneuve to the foot of Lake St. Peter, and in these sections, ice covers have formed as early as December, and remained until April, in seven out of every ten winters of which we have record. In other years, it formed early in January, and moved out in March.

No objection can be taken to attaching great importance to flooding damages, and if the principle be adopted, for comparative purposes, that the value of lands be taken at three times their selling price, and the value of buildings at twice their cost to reproduce, no material change would be made in the relative advantage of the single-stage scheme over the double-stage scheme, but the flooding of Moulinette and Mille Roches, as contemplated in the Hydro scheme "B", would be shown to be unjustified.

As much power can be secured in the International section of the St. Lawrence by the Wooten-Bowden project, as by any two-stage scheme, at 20% less cost. Any two-stage scheme to be considered, must permit an ice cover above the Long Sault dam. To attempt to operate two power plants with 40 miles of open water, as proposed by the Hydro, must obviously involve huge losses of power and difficulties in operation.

D. W. McLACHLAN.

167 Carling Ave.,
Ottawa, Ont.

GOOD ROADS ASSOCIATION TO MEET AT VICTORIA

VICTORIA will be the meeting place of the annual convention of the Canadian Good Roads Association, which will be held in June next. The final decision was taken at a meeting of the Executive of the association held in Toronto recently, at which the report of the committee delegated to visit the West was submitted. The tremendous growth of good roads sentiment, it is expected, will be manifested in the wide representation at the convention. So far official delegates from the Provinces of Quebec, New Brunswick, Nova Scotia and Ontario, including delegates from the principal cities of the East, have been delegated and representatives are expected from every section of the Dominion. Many new questions, dealing with highway construction and maintenance and increased Federal subsidies, will be dealt with by leading authorities on the various questions. Jointly with the convention will be held the second annual conference of Canadian highway officials and the annual convention of the Canadian Automobile Association.

Addressing the members of the Toronto branch of the Engineering Institute of Canada on March 9, Alfred Bicknell, of the legal firm of Bain, Bicknell, MacDonnel and Gordon spoke on the subject, "Some Legal Aspects of Engineering Problems." He pointed out that the establishment of a satisfactory contract afforded a means of avoiding legal difficulties which might otherwise be a source of trouble in engineering work. George T. Clarke, chairman of the Toronto branch of the Institute, presided.

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MOTOR BUS TRANSPORT EXTENDING

RECENT surveys of the transportation situation on this continent show a steady extension of traffic by motor bus. In a considerable number of States of the American Union important progress has been made in this regard. An important and logical use for the motor bus has developed in co-operation with the electric railways, such, for example, as the linking up of two disconnected divisions of the Pacific North West Traction Co. over a distance of forty-four miles in the Puget District in the State of Washington. In Connecticut the street railways are also making important use of motor buses as auxiliaries, as is being done at the present time in the city of Toronto. It thus appears that the inception of motor bus service on Fifth Avenue, in New York, in 1906, initiated a most important development in vehicular transport.

Great progress has been made in transport by motor bus in Great Britain. A movement of portent is now under way in England and Scotland to obtain Parliamentary sanction for a number of the railways to engage in motor bus transport. They state that in the case of short haul traffic it would be cheaper and quicker for them to convey goods direct by the public highways than to utilize the railway trackage. Naturally much opposition is being offered by the existing motor bus and motor truck companies, but the logic of the position of the railways in the matter appears to be clear.

In this growing popularity of the motor bus, careful comparison must be made between it and electric railway as a transportation agency. Recent experience indicates that the electric railways are having a hard time of it.

It is said, for example, by Ralph M. Sparks, in a recent number of "Bus Transportation," that between 1915 and 1920 ninety-one electric railway companies operating 5,330 miles, or more than one-fifth of the total of electric railway mileage in the United States, went into receivership. In 1920 alone, over 628 miles of electric railway service was suspended and of this mileage 438 miles was permanently abandoned. In 1921 there were 118 miles of service suspended and 150 miles abandoned. Such conditions have made it extremely difficult for the electric railway companies to finance reconstruction work or rehabilitation of equipment. As compared with motor bus transportation, the electric railway is saddled with a large capital investment for track, power plant and distribution system. Approximately from 60 to 70% of electric railway investments are involved in such. It is to be expected, consequently, that the costs per car-mile will be greater than per bus-mile, but since electric cars have larger carrying capacity than buses the cost per passenger-mile by electric car for heavy traffic will be less than by bus. For light transport and for supplementary or feeder service the motor bus, however, appears to be more economical than the electric car. The experience of the London General Omnibus Co. is that for traffic one way per maximum hour up to 3,000, the motor bus is the best vehicle, whereas from 5,000 to 8,500 the street car is preferable to the motor bus. Recent figures on operating costs show that the one-man safety car gives a car-mile cost less than the cost per bus-mile, and consequently in a considerable number of cities the competition of motor buses has been met by one-man cars.

When all the factors of the situation are considered it thus appears that there is a distinctive field for both the motor bus and the electric car and that neither one will entirely displace the other as a transportation agency. It is the duty of those charged with responsibility in providing transportation in this country to discover the exact economic field for each of these forms of transport.

QUEBEC WATER POWERS AND THE UNITED STATES

IN A recent address Premier Taschereau of Quebec evidenced considerable alarm with respect to the possibilities of the United States obtaining some form of control over the water powers on the St. Lawrence river within the confines of the Province of Quebec. He is reported as having said:

"In other words, the Americans have at the most about 700,000 h.p. only, yet they are seeking to put under the jurisdiction of the International Joint Commission the whole 4,100,000 h.p. which they hope to put to their own uses. This is to say, again, that they are asking the Province of Quebec to alienate 2,700,000 h.p., or, it may be said to put this power under international control for the immediate and eventual benefit of our neighbors across the border."

An examination of the actual recommendations of the International Joint Commission indicates that there is no danger whatsoever of any foreign control being exercised over Quebec water powers. The Commission recommends, amongst other things, that "power works" be built, installed and operated by and at the expense of the country in which they are located. There is no shadow of indication that any international control is sought or contemplated for power developments within the Province of Quebec. Even in the case of "navigation works" located on this side of the international boundary maintenance and operation are to be entirely in the hands of Canada, there being merely the right of inspection conferred on the International Board so as to ensure economy and efficiency.

In view of the very definite stand taken by the International Joint Commission on the question of control, it seems remarkable that Premier Taschereau should have made a statement such as is credited to him in this regard.

PERSONALS

F. M. WADDELL, B.A.Sc., assistant engineer for Brant County, has passed his Ontario Land Surveyors' examination.

MERLE KERR has been appointed road superintendent and engineer for Stamford Township to succeed W. T. DALE, who has resigned.

WILLIAM STORRIE of Gore, Nasmith and Storrie consulting engineers, Toronto, has been elected chairman of the Toronto branch of the Engineering Institute of Canada.

R. E. N. BARRON, of Toronto, has joined the staff of the Walkerville Hydro-Electric system. Mr. Barron was formerly connected with the Eden Washing Machine Co., Toronto.

JOHN SEARS, Toronto, has been appointed as resident engineer at Chatham, Ont., for the Ontario Department of Public Highways, succeeding L. W. Wynne-Roberts, who has resigned.

C. R. HAGEN has been appointed chairman of the Welland Water Commission to succeed the late J. R. McCollum and HARVEY BEATTY elected to fill the vacancy on the Commission.

GEORGE STEPHENSON has been appointed engineer of Bruce County with office at Walkerton, Ont. Mr. Stephenson was born 27 years ago in Huron Township and is a graduate of Toronto University.

L. W. WYNNE-ROBERTS has resigned as resident engineer at Chatham, Ont., for the Ontario Department of Public Highways, in order to accept an appointment as manager of a branch office to be opened in Chatham by Frank Barber & Associates, Ltd., consulting engineers, Toronto.

OBITUARIES

W. E. GIBSON, a prominent retired contractor of Grimsby, Ont., died there on March 15, aged 49.

WILLIAM DALY, for some years a prominent contractor of Stratford, Ont., died in that city on March 13, aged 73. The deceased was born in West Nissouri Township and moved to Stratford forty years ago.

JAMES T. HALL of the city engineer's staff, Calgary, died in that city on March 3. Mr. Hall was born near Hamilton in 1851 and in 1880 he went to Portage La Prairie. He moved to Calgary in 1907 and superintended the erection of several large buildings. Subsequently he joined the city engineer's staff and in 1914 was placed in charge of the intake of the gravity water system.

SECOND UNIT AT QUEENSTON OPERATING

CONTRACTS for 25,000 h.p. have been cancelled by the Ontario Hydro-Electric Power Commission, now that the second unit at the Queenston power plant has been placed in operation, the new unit having a capacity of 55,000 h.p. When the unit is operating at full load, about the end of this month, further contracts will be cancelled. The third unit is being installed and it is expected will be in operation in about three months. The cancellation of contracts for the supply of power which will fully load both generating units of the Queenston-Chippawa Development will result in a revenue to the Commission of approximately \$2,000,000 per annum.

PROS AND CONS RE AMENDMENT TO ENGINEERING INSTITUTE BY-LAW

CERTAIN members of the Engineering Institute of Canada petitioned the Council of that organization last fall to make a change in By-law No. 52 whereby the retiring secretary-treasurer of any branch of the Institute would be an ex-officio member of the managing committee of the branch for a period of one year following his term of office.

This proposed amendment was discussed last January at the annual meeting of the Institute and it was decided to submit the matter to the members by letter ballot, and to mail with the ballot a memorandum stating the pros and cons. An editing committee was appointed to prepare a statement of the pros and cons.

This committee, comprising J. L. Busfield (representing the cons) and A. B. Lambe (for the pros), has rendered the following report:

Further to the petition forwarded on September 29 last asking for certain changes in By-Law No. 52, the undersigned, being the editing committee appointed by the Chairman at the last annual meeting of the Institute in compliance with and under the authority of By-Law No. 75, beg to submit the following set of pro and con reasons relating to the changes proposed:

PRO:

1—Complete continuity between the outgoing and incoming executive committees of every branch is obviously most desirable. The By-Laws of the Institute now provide for part continuity by providing that the retiring chairman shall be a member of the managing committee for one year following his term of office. It is submitted that in order to insure complete continuity it is necessary to have the official familiar with the branch records and its detail business, namely, the retiring secretary-treasurer, also a member.

2—Anything which is for the good of the branch is also for the good of the Institute as a whole. It is consequently submitted that if the change proposed be a help to the branch that it will also redound to the advantage of the Institute at large, and that it is therefore most desirable.

3—Certain branches already have this provision in their By-Laws which By-Laws have been passed upon and approved by Council before becoming effective. It is submitted that if Council permits such action on the part of some branches it surely cannot be argued that the practice is bad.

4—It is true that once in a great while such a regulation might prove to be undesirable because of an unsatisfactory official. It is submitted however that the general good should not be sacrificed for a rare and improbable exception.

5—As mentioned above, some branches already have the provision suggested in their By-Laws, but some have not. It is submitted that the uniformity which will be brought about if the suggested change be made is most desirable.

6—It has been suggested that it is not desirable to change the By-Laws unless really imperative, but a critical examination of By-Law No. 52 will show that its wording needs revision in any case because it calls for branches to be managed by a committee consisting either of "A chairman and a secretary-treasurer" or else "A secretary and a treasurer and other members." In the first case the committee consists of only two members and in the latter case no chairman is provided for. It is submitted that it is very obvious that neither arrangement is a good one nor the intent of the By-Laws.

7—Most branch secretaries are recruited from among the younger followers of the engineering profession. It is submitted that the proposed change will provide an opportunity, of which there are none too many as far as Institute offices are concerned, of recognizing the work and worth of its younger members.

8—Finally, it is submitted that the distinction at present obtaining between the retiring chairman and the retiring secretary is more or less invidious and that the change proposed is nothing but a righting of an undesirable condition and a compliment and acknowledgement of work done that is nothing but due to every retiring secretary, as is also the obvious due of every retiring chairman.

CON:

1—It might be found that the secretary-treasurer was not entirely desirable.

2—It is a matter for individual branch action.

(Signed) J. L. Busfield and A. B. Lambe, Committee.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Regina, Sask., erection of Chemistry Building	Mar. 31	Mar. 7
Essondale, B.C., erection of addition to hospital	Mar. 24	Feb. 28
Delhi, Ont., erection of addition to public school	Mar. 25	Mar. 14
Hamilton, Ont., erection of a Masonic Temple	Mar. 25	Mar. 14
Lethbridge, Alta., masonry construction	Mar. 30	Mar. 14
Morton, Man., gravelling of several roads	Mar. 25	Mar. 14
Ontario, Province of, supply of materials for Highway Department	Mar. 28	Mar. 14
Ottawa, Ont., electrical supplies	Mar. 24	Mar. 14
St. Catharines, Ont., road construction and material	Apr. 1	Mar. 14
Chippawa, Ont., construction of concrete intake structure and ship channel in Niagara River	Apr. 10	Mar. 14
Toronto, Ont., bituminous concrete pavement in Aurora and York Tps., for Toronto and York Roads Commission	Mar. 24	Mar. 14
Halifax, N.S., highway construction on Halifax-Yarmouth Road	Mar. 24	Mar. 14
Halifax, N.S., highway construction on Halifax-Amherst Road	Mar. 27	Mar. 14
Halifax, N.S., highway construction, Yarmouth-Shelbourne County line to Woods Harbor	Mar. 30	Mar. 14
Ontario, Province of, widening and deepening the channel of the Welland River and a portion of the Queenston-Chippawa power canal..	Apr. 10	Mar. 14

BRIDGES, ROADS AND STREETS

Birch Cliff, Ont.—The Township Council decided to construct sidewalks and improve the roads on Oakbridge, Warden Park and Bonnington Ave. Also a sidewalk on Kingston Road, from Stop 12 to Birchmont Road. Township Clerk, W. D. Annis, Scarboro.

Calgary, Alta.—The City Council passed the recommendation of the City Commissioners that the widening and improvement of Seventeenth Ave. west be undertaken at a cost of \$4,095. City Engineer, G. W. Craig.

Chatham, Ont.—The paving of Queen St. South will be undertaken by the Board of Works this year.

Chatham, Ont.—A special session of the Kent County Council has been called for March 23, when the question of good roads will be discussed and the program for the year will be mapped out.

Coleman, Alta.—A by-law authorizing the expenditure of \$5,000 for the construction of pavements will be submitted.

Durham, Ont.—The Town Council expects to start work this year on the construction of permanent roads. Gara-

fraxa St. will probably be the first street built. Town Clerk, Wm. B. Vollet.

Fredericton, N.B.—A delegation representative of the residents on the shore road between Musquash and Lepreau, presented a petition to the Government asking that that section of the highway be adopted as part of the trunk road between St. John and St. George, rather than the present trunk road which runs inland.

Hamilton, Ont.—The expenditure on suburban roadways will total about \$80,000 this year, according to a statement made by ex-Alderman Thompson, member of the suburban areas commission.

Hamilton, Ont.—Wentworth County Council instructed Road Superintendent T. R. Allison, Hamilton, to prepare an estimate of the cost of constructing a bituminous top road for the Brock and Binbrook roads.

London, Ont.—The proposed new Hyde Park overhead bridge will be erected here shortly, according to information received here from the Grand Trunk officials.

Manitoba, Province of.—The Provincial Government will be asked to authorize the building of four north and south roads as provincial highways throughout the western portion of Manitoba, as a result of a strong resolution passed at the annual meeting of the Brandon District Good Roads Association.

Mimico, Ont.—Permanent pavements will be laid this year in Eastbourne Crescent, Robert St. and Superior Ave.; also sidewalks on Pidgeon, Central and Robert Streets, Eastbourne Crescent and Queen's Ave. Town Clerk, J. A. Telfer.

Montreal, Que.—It is expected that construction work on the proposed \$3,000,000 highway through the Island of Montreal will be commenced this year. The thoroughfare will be 150 feet wide and will extend from the bridge terminal at Bout de l'Île to St. Anne de Bellevue.

Montreal, Que.—The proposal for a new bridge connecting the McGill street approach to the harbor with Victoria bridge basin, St. Helen's Island and the South Shore is strongly favored in the Montreal Harbor Commission's report for 1921, just issued by W. G. Ross, Farquhar Robertson and Brig.-Gen. A. E. Labelle, who were commissioners from 1913 to 1921 inclusive.

Montreal, Que.—The advocacy of another bridge across the St. Lawrence is becoming more and more general, and inside of a short time it is expected that the larger bodies of business men will go on record as being favorable. It was stated at the Chamber of Commerce recently. The Federal Government will be asked for a grant in order that a start may be made on the preliminary plans and specifications.

Newmarket, Ont.—The Town Council plans to construct permanent pavements on Prospect Ave., from Pearson St. to Huron St., and on Queen St., from Prospect Ave. to the G.T.R. bridge. Town Clerk, P. J. Anderson.

Ontario, Province of.—A petition addressed to the Minister of Public Works and Highways of Ontario is being circulated among the residents of Deseronto, East Hastings and North Prince Edward counties, asking that the Provincial Government construct and maintain a bridge over the Bay of Quinte to connect the Provincial County highway running from Deseronto to the ferry and from the ferry to Picton.

Ontario, Province of.—The Department of Highways awarded the contract for work to be done at the head of James St., Barton Township, to Roy Honsberger, at \$5,421. Other tenders submitted were: Barton Township Road

Superintendent, \$5,428; W. A. Taylor, \$5,428; F. H. Dickenson, \$6,750; Canadian Engineering and Contracting Co., \$7,089; Dufferin Construction Co., \$7,348; Canadian Engineering and Contracting Co., \$7,089; Dufferin Construction Co., \$7,348.50; W. H. Sheridan, \$13,440.

Ottawa, Ont.—The location of the proposed new bridge over the C.P.R. tracks on the Bowesville Road has been tentatively arranged. The bridge may be erected next summer or fall. Address Alan K. Hay, engineer of the Suburban Road Commission.

Owen Sound, Ont.—Grey County Council decided to go ahead shortly with the construction of the uncompleted portion of the county provincial road between Owen Sound and Meaford, a distance of seven miles. Road Superintendent, John Johnston, Owen Sound.

Ottawa, Ont.—The Ottawa Improvement Commission will probably complete the Experimental Farm Riverside Park driveway next summer. The Commission also plans the construction of bridges from the south shore of the Ottawa river to the three islands in the river. The canal road on the south side, from Bronson Ave. to Bank St., will also likely be finished this year.

Owen Sound, Ont.—The Suburban Area Commission will shortly hold a meeting to complete plans for the coming year's operations. There will be approximately \$50,000 spent on roads in this section this year, which will likely include several miles of concrete roads. The commission consists of C. H. Thompson, A. S. Donald, of Derby, and John Eaton, of St. Vincent.

Port Arthur, Ont.—The City Council has agreed to put into shape and to maintain the road to the Provincial Pulp and Paper Company's mill until such time as financial conditions warrant the construction of a subway or overhead bridge to cross the railway lines in the North End. City Engineer Antonissen informed the Council it would cost \$79,000 to construct an overhead bridge, approximately \$50,000 to complete a subway, and about \$1,500 to put the present road into shape.

Quebec, Que.—The Legislative Assembly passed the bill providing for an expenditure of \$7,500,000 this year on highway betterments.

St. John, N.B.—Council authorized Com. Frink to call for tenders for 175 tons of asphalt.

St. John, N.B.—A sketch blue-print of the steel and reinforced concrete viaduct designed by the C.P.R. for Douglass Ave. was submitted to the Council.

St. Thomas, Ont.—The plans and estimates in connection with the proposed underground work in Hiawatha St. have been approved by both the Provincial and Federal Departments of Public Works. The construction of an asphaltic-concrete pavement on this street will likely be started soon. City Engineer, W. C. Miller.

Sandwich, Ont.—The Town Council instructed the Town Engineer to prepare plans and specifications for the paving of Partington Ave., from London to Wyandotte Streets, and Chippawa St., from Sandwich St. to the Essex Terminal Railroad.

Saskatoon, Sask.—The construction of a bridge over the city park at a cost of \$2,500, is planned. City Clerk, Andrew Leslie.

Simcoe, Ont.—Norfolk County Council decided to raise \$100,000 to supplement the usual amount for highway construction.

Simcoe, Ont.—The Norfolk County Council instructed County Engineer G. R. Marston, of Simcoe, to prepare plans and call for tenders for the construction of tarvia penetration or concrete roadway, including grading and drainage, on a portion of the county highway north from Simcoe.

Stratford, Ont.—Mayor Gregory submitted to the City Council plans prepared by the Grand Trunk Engineering Department for the proposed bridge in Romeo Ward. Together with these plans, which showed sketches of subways and bridges at Well and King Streets, and a bridge at Front St., were figures of the estimated costs, ranging from \$26,000 for a 20-ft. bridge across Front St., to \$756,602 for a

40-ft. subway, 1,090 ft. in length at Well St. The plans and estimates were referred to the Committee of the Whole Council for consideration.

Tilbury, Ont.—Government surveyors are working between Tilbury and Chatham on the Provincial highway, which will be 86 ft. wide from end to end.

Toronto, Ont.—The extension of Riverside Ave from Carlaw Ave to Pape Ave., so as to make the Pape Ave. car line possible, was decided on by the Board of Control. Approximate cost, \$16,000.

Toronto, Ont.—The City Council and the Harbor Board will approach the Dominion Government with a view to securing an appropriation in next year's estimates for the construction of a bridge to Toronto Island.

Toronto, Ont.—The Edgewood and District Ratepayers' Association decided to approach the Civic Works Department regarding the paving of that portion of Edgewood Ave., near Kingston Road, which is a fill-in over Small's Pond. The association also appointed a committee to look into the matter of improving Ashland Ave., between Coxwell and Pullen.

Victoria, B.C.—Tenders for the railway portion of the Johnston Street bridge so far opened are about \$50,000 more than the estimates provide for, in spite of the fact that the price of steel has declined considerably since the estimate was prepared. It is probable that new tenders will be called for.

Victoria, B.C.—The Canadian Bridge Co. was the only firm that submitted a tender on the removal of the Esquimalt & Nanaimo steel railway span. The company will dismantle, remove and store the bridge for \$8,500, and for \$12,500 it will place the span at Rock Bay or some other suitable site on a substructure prepared by the city. The tender was referred to the City Engineer and Public Works Committee.

Windsor, Ont.—The Essex Border Utilities Commission contemplates widening Tecumseh road to 100 ft.

Windsor, Ont.—The Essex Border Highways Committee will spend \$607,000 in constructing and maintaining roads in Essex County this year.

WATER, SEWAGE AND REFUSE

Coleman, Alta.—The construction of a water works system to serve West Coleman is projected. A by-law will be submitted.

Galt, Ont.—Manager W. H. Fairchild, of the Public Utilities Commission, is preparing a report on a proposition to lay a water main across the river to feed the east side of the city.

Kitchener, Ont.—The contract for the electrical work in connection with the new pumping station on which work will start about the middle of April, has been let by the Water Commission to the Westinghouse Co. Contract for the crane has been let to the Herbert Morris Crane and Hoist Co., of Niagara Falls, Ont.

Long Branch, Ont.—A petition signed by practically all the residents will be presented to Etobicoke Township Council, urging the creation of a water area at Long Branch and the immediate installation of a water system.

Macoun, Sask.—Extensions to C.P.R. water supply mains at Macoun and Weyburn will be laid next summer, involving the construction of about three miles of new pipe line at the two points. Prices for cast iron pipe to be used in this work, and also tenders for the construction of the work, are being asked for by officials of the company in Winnipeg.

Mimico, Ont.—The Town Council passed a by-law providing for the raising of \$13,000 for the installation of an additional pump in the sewage pumping station. Town Clerk, J. A. Teller.

Mimico, Ont.—Sewers will be constructed this year on Elm St., Central St., Cavell Ave., Melrose Ave., Milton St., Algoma St., Dean St. and George St. Also water mains on Dean St., George St., Edith Ave., Central Mel-

rose Ave., Milton St. and Algoma St. Town Clerk, J. A. Telfer.

Niagara Falls, Ont.—The City Council passed a by-law for the construction of a sewer in the Pine Grove section. City Clerk, W. J. Seymour.

Niagara Falls, Ont.—The City Council intends to construct a sanitary sewer on Simcoe St., between Buckley Ave. and St. Lawrence Ave., at a cost of \$1,917.09. City Clerk, W. J. Seymour.

St. Thomas, Ont.—Application has been made for Government assistance in the construction of a sewer under the eastern section of Malakoff St. City Engineer, W. C. Miller.

Smith's Falls, Ont.—The Provincial Health Department is insisting upon the installation of a filtration plant in connection with the waterworks system.

Smith's Falls, Ont.—The Town Council has been served with a writ at the instance of the Provincial Board of Health, for non-compliance with an order for the installation of a filtration plant.

Swansea, Ont.—York Township's plans for installing a complete sewerage system here, were outlined at a recent meeting by Engineer R. O. Wynne-Roberts. If the Legislature passes the required legislation, work on the new sewerage system will likely be commenced next summer.

Toronto, Ont.—The Works Committee decided on the construction of a sanitary sewer on Cortleight Crescent.

Welland, Ont.—The Welland Water Commission is considering extending the water main on Major Street, east of Myrtle Ave.

Welland, Ont.—Members of the Welland Water Commission, after a conference with representatives from the Water Commissions of the municipalities of St. Catharines, Merritt and Thorold, decided that representatives from these municipalities should wait upon the Minister of Railways and Canals, at Ottawa, and lay before him the urgent need of constructing the proposed pipe line from Port Colborne to St. Catharines, by reason of the building of the Welland Ship Canal and diverting the waters of the Chippawa Creek thereto, thus polluting the source of supply of the various municipalities.

LIGHT, HEAT AND POWER

Brantford, Ont.—The governors of the General Hospital are considering the establishment of an auxiliary lighting plant.

Edmonton, Alta.—The supplying of Edmonton with power from an extensive coal area in this district is contained in an offer which A. E. Farncomb, surveyor and civil engineer, has submitted to the city council on behalf of himself and a number of associates. Delivery would be made at the city limits, as Edmonton has its own distribution system available. The city's proposal to submit a by-law for \$115,000 for improvements and additions to the power plant is ascribed as the reason for the offer.

Montreal, Que.—For some years past a corporation by the name of the Lachine Rapids Power Co. has been gathering data and preparing to finance a plan for the erection of a gigantic dam below the rapids to Heron Island in the St. Lawrence River, but the outbreak of the war prevented the action. It is rumored that efforts to put the scheme on its feet, through the reorganization and strengthening of the concern, are to be begun shortly. It is said that the work itself would cost in the neighborhood of \$175,000,000.

Montreal, Que.—In connection with the passing of the bills of the Montreal Service Corporation and Canadian Light and Power Co. by the Quebec Legislature, the statement is made here that the completed merger of these power interests will result in a capitalization of approximately \$100,000,000. With the powers now granted, the development of the Ottawa River at Carillon will be proceeded with as soon as weather conditions will permit, a considerable portion of preliminary work having been already accomplished. It is further claimed that the consolidation will finally result in the production of upwards of 300,000 h.p., much of which has already been contracted for. To carry

the work to completion a total of \$40,000,000 will be required, it is claimed, all of which will be expended during the next two years. The financial plans are well advanced.

Toronto, Ont.—Sir Adam Beck, Mayor Maguire and the local Hydro Commission met recently to discuss this year's program of capital expenditures by the city Hydro system, which calls for \$2,500,000. The chief subject of consideration was the new Hydro head office building at the corner of Front and Yonge Streets.

RAILWAYS

Montreal, Que.—At a recent meeting of representatives of the City Council and the Tramway's Commission, it was definitely decided to build a car line to the top of Mount Royal.

Toronto, Ont.—A formal application for \$13,000,000 for capital expenditure on the rehabilitation of the street railway was sent to the Mayor and Board of Control by the Transportation Commission. This amount is intended to cover this year's work, including the widening of the devil strip on 25 miles of track, and the replacement of sections of worn-out track in various parts of the city. It also includes provision for new car barns at Eglinton Ave. and an additional number of new cars.

Sheho, Sask.—The C.P.R. has sent out a survey party in connection with the construction of a railway northwest of Sheho.

FACTORIES AND LARGE BUILDINGS

Annapolis Royal, N.S.—The contract for the construction of a Town Hall was awarded to Allen & McGaw, of St. John, N.B., the price being \$15,985.

Blairmore, Alta.—The Provincial Government plans the erection of a court house and jail.

Brantford, Ont.—The Crown Electrical Manufacturing Co. plans to enlarge its plant. President, Joseph Ruddy.

Brantford, Ont.—The City Council will be asked to grant \$8,000 for the erection of an extension to the Collegiate Institute.

Bridgeburg, Ont.—New plans are being prepared for the proposed Town Hall. Instead of costing approximately \$30,000, the new building will cost \$42,000, according to latest estimates. Architect, C. M. Bortor.

Burlington, Ont.—The School Board accepted the bulk tender of the Pigott-Healey Co., Hamilton, for the construction of a High School, the amount of their tender being \$58,600.

Burns' Lake, B.C.—The Burns' Lake Hotel was destroyed by fire.

Calgary, Alta.—Tenders will be called at once for the erection of an educational building in connection with the Central Christian Church. Architect, D. S. McIlroy.

Copper Cliff, Ont.—The following contracts have been awarded in connection with the erection of a public school: General trades, Cecchetto & Knight, Copper Cliff; mechanical trades, Percy Morrison, Sudbury.

Glenboro, Man.—Contract for the erection of a school has been let to Crowe & Olafson, of Glenboro.

Hamilton, Ont.—A \$20,000 labor temple will be erected on Catharine St.

Hamilton, Ont.—A \$70,000 building is to be erected to be occupied exclusively by the medical profession.

Hamilton, Ont.—A permit has been issued to H. C. Gummo for the construction of brick and concrete buildings for the Hamilton Electric and Stereotype Co. at West Ave. and King William St. Cost, \$15,000.

Hamilton, Ont.—The ratepayers of West Hamilton empowered the trustees with authority to request the Anaster council to issue debentures amounting to \$40,000 for the purchase of a site and the erection of a school. Address W. Jarman.

Kingston, Ont.—The Provincial Government has decided to rebuild the Eastern Dairy School, according to an announcement made by Hon. Manning Doherty.

Kingston, Ont.—The Ontario Government has granted \$75,000 to Queen's University Library, which will make possible the commencement of work on the proposed new building this spring.

Kitchener, Ont.—The following contracts have been awarded in connection with the erection of a new building for Suddaby School: General contract, Casper Braun; heating and plumbing, Batter & Freiburger. Approximate total cost, \$160,000.

Leaside, Ont.—The construction of a four-room school is under consideration.

Leaside, Ont.—Durant Motors of Canada plan the immediate construction of a building, 80 by 600 ft. The Auto-Lite Co. plans to establish a plant here in conjunction with the Durant enterprise.

London, Ont.—The erection of a wholesale warehouse for James Cowan & Co., and a store for Cowan Hardware, Ltd., will be commenced at once by the executives of the D. J. Cowan estate. Each building will cost \$60,000.

Moncton, N.B.—The Minto Sample Rooms building was destroyed by fire. Owner, Carl Doull.

Moncton, N.B.—The Board of School Trustees will apply to the Provincial Legislature for authority to issue debentures to the amount of \$150,000, part of the amount to be used for the purchase of additional school lands, and for the erection and equipment of additional school buildings. Secretary, Amos O'Brien.

Montreal, Que.—A new Mount La Salle Tuberculosis Hospital is to be built in Maisonnette Park.

Montreal, Que.—The Private Bills Committee of the Quebec Legislative Council granted the city of Montreal power to borrow \$1,500,000 for the erection of a new City Hall.

Montreal, Que.—F. G. Robb has been appointed to prepare plans for a new engineering building for McGill University. K. G. Rea has been appointed as consulting architect.

Montreal, Que.—The two-storey brick building occupied by the Imprimerie de L'Est, at 144 Eighth Ave., Pointe Aux Trembles, was destroyed by fire recently, the loss being estimated at \$30,000.

Mount Dennis, Ont.—Mount Dennis Methodists have decided to erect a new church at Eglinton and Pearen Avenues, at a cost of \$35,000.

Niagara Falls, Ont.—Imperial Oil, Ltd., plans the erection of a gasoline station on the southwest corner of River Road and Bender Hill.

North Toronto, Ont.—The members of Eglinton Methodist Church plan the erection of a new building at a cost of \$60,000.

Oshawa, Ont.—In the near future work will commence on the new St. George's Memorial Church, which is to be erected on Centre St.

Oshawa, Ont.—The Town Council instructed the Oshawa Housing Commission to erect ten additional houses, making the program for this year twenty.

Oshawa, Ont.—A site has been selected on Mechanic St. for the construction of the arena by the Oshawa Arena Co. Plans of the proposed structure may be seen at the office of H. E. Smith.

Oshawa, Ont.—Instead of building a 16-roomed school on Centre St. as has been proposed, it is probable that two schools will be erected. If this plan is carried out, a 12-roomed school will be built on the Centre St. site and a smaller school will be erected in an outlying district.

Oshawa, Ont.—It is estimated to expend \$107,000 for general and high school purposes. In addition there is already before the council an application from the Board of Education for \$20,000 for a new 16-roomed school and administration building and \$20,000 for improvements on another school.

Oshawa, Ont.—W. E. Phillips, Ltd., has secured an option on the plant of the Thornton Rubber Co., which was recently gutted by fire. The new company plans to rebuild the plant and equip it with new machinery for the manufacture of woodwork, etc. It is understood that

Mayor Stacey's firm has been awarded the contract for the reconstruction of the building.

Ottawa, Ont.—An additional storey will be built to Lauder Hall.

Ottawa, Ont.—A large addition to cost about \$150,000 will be added to the University of Ottawa building this year. The plans have been completed and work will likely start within a month.

Ottawa, Ont.—The matter of completing the Victory Tower of the Parliament Buildings will be taken up immediately with Dr. J. H. King, Minister of Public Works, by John Pearson, Architect, of Toronto.

Ottawa, Ont.—Work will likely start within a month on the reconstruction of the Hotel Cecil, Sparks St. and the erection of a new hotel in connection with same, the total estimated cost of all construction being \$330,000.

Ottawa, Ont.—Either a 300-room hotel or a large theatre, either of which will cost approximately \$330,000, will likely be erected on the site formerly occupied by the Dominion Theatre. Further information from Grant P. Davidson.

Pembroke, Ont.—Tenders have been called for a school for the East Ward.

Pembroke, Ont.—The contract for the erection of a cottage hospital has been let to W. C. Keighley, Town Architect. The plans call for a building estimated to cost approximately \$100,000.

Peterborough, Ont.—The Western Clock Co. plan the erection of a factory at Hunter St. East and Armour Road, at a cost of \$80,000.

Preston, Ont.—The Board of Education has engaged F. W. Warren, of Hamilton, as architect for a new ward school to be erected next summer. Mr. Warren is also preparing plans for a large four-storey addition to the Hurlbut Shoe Company's plant at Preston.

Quebec, Que.—Plans for a school on Grant St., St. Roche's Ward, are being prepared by Emil Tanguay, architect, for the Catholic School Commissioners. Estimated cost, \$55,000.

St. Boniface, Man.—Fire destroyed the Lemontagne Block, the estimated loss being \$40,000.

St. Mary's, Ont.—The Collegiate Institute Board is asking the Town Council for \$18,000 for improvements to the building.

St. Thomas, Ont.—The proposed Technical and Vocational School for this city now has the unanimous backing of the financial committee of the city council.

Saltsfleet Tp., Ont.—The construction of a continuation school is projected.

Sarnia, Ont.—The erection of a \$75,000 arena next year is projected.

Sarnia, Ont.—T. H. Cook, chairman of the industrial committee of the City Council, has intimated the possibility of a grain-elevator for this port.

Summerland, B.C.—Fire destroyed the Bank of Montreal, office of the Review newspaper, postoffice building and the Empire Block.

Sussex, N.B.—The Grammar School, valued at \$65,000, was destroyed by fire recently.

Sydney, N.S.—Specifications and estimates for the proposed Cozzolino Hotel were submitted to a meeting of business men by Architect Dwyer, of Halifax. The cost of a 97-room hotel of fireproof construction would be \$280,000 and the cost of a similar structure, non-fireproof, would be \$244,000. The meeting decided to favor the former.

Toronto, Ont.—The Separate School Board will erect a school in Silverthorn district. Chairman, D. A. Carey.

Toronto, Ont.—Work has started on the erection of a \$65,000 veterans' clubhouse at the corner of College and Crawford Streets.

Toronto, Ont.—Fire damaged the building and contents of the Allen Manufacturing Co., Simcoe & Pearl Streets, to the extent of \$50,000.

Toronto, Ont.—Fire damaged the storehouses of the Kelley Flour & Feed Co., at 778-780 Dovercourt Road, to the extent of between \$8,000 and \$10,000.

Toronto, Ont.—Plans have been prepared for the erection by the city of a Fire Hall on the south side of Commissioners St. Estimated cost, \$40,000.

Toronto, Ont.—Controller W. W. Hiltz plans the erection of about twenty stores next summer in the Danforth Ave. district, at a cost of approximately \$250,000.

Toronto, Ont.—The members of St. Aidan's Anglican Church decided to proceed at once with the erection of a Memorial Hall at a cost of \$65,000. Rector, Rev. T. H. Cotton.

Toronto, Ont.—A permit has been issued to the Imperial Clothing Co. for the erection of a six-storey building at 355 to 359 Adelaide St. west. The estimated cost is \$60,000.

Toronto, Ont.—A new theatre to cost \$125,000 is to be built at the corner of Bloor St. and Beresford Ave. The theatre is to be built on property purchased through George B. Williams, real estate broker.

Toronto, Ont.—The members of Westminster Presbyterian Church have started a campaign for the raising of \$50,000 within a week with which to start building a new church on the site of the one destroyed by fire.

Thornhill, Ont.—The Trustee Board have awarded to William Riddell, of Thornhill, contract for building four-roomed school. James, Proctor & Redfern, Ltd., Architects and Engineers, 36 Toronto St., Toronto, are the architects.

Toronto, Ont.—Arrangements are being made for the erection of a large factory, planing mill and lumber yard on the Kennedy Road, south of the G.T.R. tracks. The plans include the building of a brick and concrete main factory, at a cost of \$60,000.

Toronto, Ont.—The Board of Education has awarded the following contracts: Hardware, Queen Victoria School, Canada Hardware Co., \$1,340; plastering, Island School, Andrew Petrie, \$645, electric wiring, Earls Court School, Canada Electric Co., \$71.

Toronto, Ont.—Plans and specifications for the completion of the addition to the High School of Commerce building were ordered by the Advisory Commercial Committee of the Board of Education. Chief Architect Dyson informed the committee that the original plans would be followed, with slight variations. Tenders will be called for the work.

Toronto, Ont.—Development operations on a large scale have commenced on the property of the late Sir William Gage, on the northwest corner of Bathurst St. and Davenport Road, which comprises about 22 acres, and of which A. F. Le Page has just secured control. The venture, which includes the erection of 60 houses, is estimated to cost well over \$1,000,000.

Toronto, Ont.—The executive committee of the Methodist General Board of Missions at a recent meeting voted \$25,080 for use of the Methodist Union of Toronto for church buildings in the suburbs of Toronto and vicinity; two sums of \$28,000 for new hospitals at the new Canadian mission centres at Hafford, Sask., and Vita, Man.; \$15,000 for the erection of a building at Sydney, C. B.; and \$9,000 for a building at Sault Ste. Marie, Ont. A resolution was passed urging the Federal Government to take action regarding the building of Indian Industrial institutions at Cognateeyza, B.C., and at Edmonton, Alta.

Truro, N.S.—A proposal to establish a public hospital here at a cost of \$80,000, was placed before the Town Council. The Council was asked to submit a by-law to the ratepayers authorizing an expenditure by the Town of \$10,000 towards the building fund. Address W. R. Campbell, vice-president, hospital trust.

Vancouver, B.C.—Senator S. J. Crowe has taken out a permit for a \$6,000 office building at 2902 Granville St.

Vancouver, B.C.—The United Cigar Stores, Ltd., intend to erect a two-storey building on Granville St., at a cost of \$35,000.

Vancouver, B.C.—Work will start about the end of April on the construction of separate schools in St. Patrick's parish. Address Rev. L. Forget.

Vancouver, B.C.—E. D. Farmer, of Fort Worth, Texas, will build a three-storey office building on the southwest corner of Granville St., work to start about May 1.

Walkerville, Ont.—A plan is under consideration to purchase a site on the Tecumseh road for the erection of a hospital.

Waterloo, B.C.—The Department of Education will likely erect a school here.

Walkerville, Ont.—The Walkerville Hydro-Electric Commission has chosen the drawing submitted by Harold McEvers, architect, as the best of 10 submitted for the erection of their new Executive and office building, and Mr. McEvers has been instructed by the commission to prepare working plans. The estimated cost of the building is about \$60,000.

Welland, Ont.—The City Council has approved of the erection of a Market Hall at a cost of \$15,000. City Clerk, W. E. Forster.

Weston, Ont.—The Board of Education plans the erection of an addition to the High School at a cost of \$115,000.

Weston, Ont.—A delegation will interview the post-master-general at Ottawa to urge the early erection of a post office here.

Weston, Ont.—G. H. Gray, Industrial Commissioner, reported to the Town Council that a large new industry is proposing to locate here.

Westmount, Que.—The erection of a new City Hall, Fire and Police Station is projected.

Windsor, Ont.—A permit has been issued for the erection of a new Windsor and Walkerville Technical School, on Giles Boulevard and Elsmore Ave., to cost \$689,000.

Windsor, Ont.—A new church site has been purchased by Bruce Avenue Baptist Church. Work on the erection of the church will be started shortly. Pastor, Rev. Owen C. Gray.

Windsor, Ont.—W. E. Wood & Co., contractors for the new technical school, have secured a permit to proceed with the construction of the building. The estimated cost is \$689,000.

Winnipeg, Man.—The Carter-Halls-Aldinger Co., Ltd., contractors for the erection of a four-storey addition to the Great West Life building, Lombard St., have agreed to have the work completed by October 1, at a cost of \$300,000.

York Tp., Ont.—The school trustees and ratepayers of School Section No. 26 decided to erect 12 additional rooms to the new building now in course of erection on Sannon Ave., at an estimated cost for building and equipment of \$185,000.

MISCELLANEOUS

Alberta, Province of.—The following companies have been granted Provincial charters: New Nakamun Coals, Gas and Petroleum, Ltd., Edmonton, \$2,000,000; Bell Metal Products, Ltd., Edmonton, \$50,000; Polar Aerated Water Works, Ltd., Calgary, \$35,000.

Hamilton, Ont.—The Board of Control approved of the following tenders for annual supplies being awarded: Grey iron castings, Hamilton Foundry Co., at \$2.93 per 100 lbs.; cast iron pipe at \$62 per ton, and special castings at 5 cents per lb., Gartshore-Thomson Pipe & Foundry Co.; extension boxes, Forwell Foundry Co., Kitchener, at \$2.85 each for the large size and \$2 each for the small size; limestone dust, Crushed Stone Co., Ltd., at \$6.90 per ton; crushed stone and screenings, the Canada Crushed Stone Co. and the Wentworth Quarry Co.; concrete sand, Armstrong Supply Co. and the Hamilton Sand and Gravel Co.; asphalt sand, the Sand and Supplies Co., Ltd.; sewer pipe and junctions, Hamilton and Toronto Sewer Pipe Co.; gate valves, the Kerr Engine Co. and Drummond McCall Co. The Tallman Brass Co. was awarded contracts for a good percentage of the total brass supplies. This firm will supply lead pipe at 9½ cents per lb., bronze and manganese hydrant casting at 23 cents per lb. and ordinary brass for the same purpose at 30 cents per lb. A contract was

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Maryland Street Concrete Arch Bridge, Winnipeg

Two 150-Ft. Spandrel Filled Arch Spans — Careful Consideration of Aesthetics — Economically Superior to Open Spandrel Arches — Gravel and Crushed Rock Combined — Built in Halves to Maintain Traffic

BY. J. F. GREENE

Member of Firm of C. D. Howe & Co., Consulting Engineers, Winnipeg, Man.

PROVISION is made for traffic across the Assiniboine River between the business section and the best residential section of the city of Winnipeg in the new reinforced concrete arch bridge known as the Maryland Street bridge. The deck, consisting of a roadway 50 ft. wide and two side-walks each 7 ft. wide, provides for four lines of vehicular traffic including streets cars, with a maximum grade of 2%. While the structure, as a type of the standard barrel arch class of concrete bridge is not an object of special interest, the proportioning of the parts of this particular bridge to form a harmonious whole, and the mental processes involved in the proportioning may be of interest to

ous irregularities, due to the method of constructing concrete structures; each lift, or day's run of concrete is distinctly outlined in any exposed concrete surface; board marks have distinctive entities of different shades of gray, some dark, some light, due probably to the absorption capacities of the several boards; any yielding of forms, no matter how slight, results in offsets or waves; occasionally rock pockets appear which must be covered by disappointing patches. All such appearances are irregularities, and are displeasing to the eye. It is incumbent upon the designer so to proportion the major members of the structure as to make it pleasing and dignified, while at the same time



FIG. 1—COMPLETED MARYLAND ST. BRIDGE, WINNIPEG

those engaged in the solution of similar problems. A general view of the completed structure is shown in Fig. 1.

The determination of the number of spans was not left to the designers. While comparative estimates disclosed the fact that a three-span bridge was slightly cheaper than a two-span structure, and while aesthetic precedent would demand three spans rather than two, the Department of Public Works objected to the location of the south pier in the navigation channel and intimated that only a two-span bridge would be acceptable. The elevation of the crown of the south span was fixed as a result of the clearance set by the government for navigation purposes; hence the curves for the arches had been approximately predetermined, at least enough so to enable one to make preliminary sketches to ascertain how to treat most effectively the abutments, piers, spandrel walls and approaches.

Aesthetic Considerations

A slight digression upon the architectural limitations of concrete as applied to bridges, may not be amiss here. A concrete bridge presents all exposed faces of one color, a dull monotonous gray. These faces in turn disclose vari-

so to accentuate the minor members by the use of pilasters, inserts and grooves as to withdraw the attention from the essential defects of concrete surfaces.

It has been assumed as axiomatic that the dimensions and proportions of the several parts should be indicative of the service which each part contributes to the stability of the whole. The abutments, marking clearly the river banks and the limits of the arch spans, should appear to the observer as of sufficient mass to withstand successfully the horizontal thrust from the adjacent arch span. The pier, while of sufficient mass to carry the vertical loads transmitted from the arches, should present faces so proportioned as to offer the least obstruction to the passage of ice and water.

Preliminary Studies

With these limitations and axioms in mind, preliminary sketches were made. In one sketch an excessive use of horizontal lines, and in another an equally excessive use of vertical lines, disclosed the basis of the proper treatment for this structure. The structure outlined appeared to be squatly, this quality being exaggerated by the excessive

use of horizontal lines and relieved greatly by the appearance of vertical lines. Proceeding from the assumption that the structure lacked depth, abutments and piers were increased in height to a level above that of the handrails; the surfaces were relieved with deep vertical grooves, and even the form boards were placed vertically to further the illusion of depth. The spandrel wall surfaces were broken up by pilasters which in turn were exaggerated by inserts at both edges to accentuate vertical shadow lines, contributing thereby to the depth illusion.

To conceal the results of yielding forms and outline of each day's run, grooves were left in the concrete at regular intervals, both in the arches and in the walls; with each day's run ending in a groove, the line of the joint was concealed and in addition the grooves themselves gave shadow lines which tended to relieve the monotony of the large flat gray surfaces.

In proportioning the exposed portions of the side-walk slabs and brackets, it was expedient to exceed the structural requirements of the design, lest the parts should appear too light for stability. By breaking the sloping side faces of brackets into several vertical faces, an illusion of breadth and strength was produced and the impression which would have resulted from the monotonous succession of plain brackets altered to a definite and pleasing one.

Aesthetic Treatment of Deck

This completes the consideration of the proportioning of these parts of the structure, which should appear to observers standing either upstream or downstream from the

have been set high enough on the poles to eliminate dangerous shadows from passing cars.

Principal Structural Characteristics

A consideration of the structural features may now be in order. The adoption of a solid barrel, earth filled arch, rather than an open, spandrel, reinforced, concrete deck bridge, rested primarily upon economic grounds and secondarily upon structural considerations. With an average fill of 10 ft. the earth fill arch showed a saving of 25% under an open spandrel arch; on the approaches the saving was greater, since the increase in the cost of the deck was not offset by reduction in the substructure due to reduced dead loads. Further, the earth fill type, exposed only at the intrados, is less subject to movement and cracking due to extreme temperature changes than the open spandrel type. In addition the solid barrel type offered greater mass and at the same time less obstruction to the passage of ice.

In the design of the approach retaining walls, a radical departure from standard practice was made in that the foundations for these walls were carried down through more than 20 ft. of excavation, and bonded into the rock. This unusual treatment was due to exceptional conditions at the site. Just east of the north end of the bridge, the Cornish baths had given evidence of a strong tendency to move toward the river, and a few hundred feet west of the bridge, several apartment blocks had actually moved and tilted; one section of one of these blocks had been condemned and demolished. The evidence was clear that the bank was not stable and that structures resting on this bank

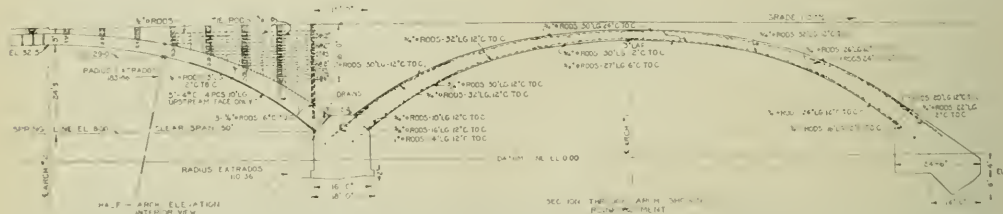


FIG. 2—DETAILS OF ARCH RIBS AND SPANDREL WALLS

bridge. The treatment of the deck of the bridge presented a separate and a different problem. Smooth, easy approaches from connecting streets with the least possible grades attainable were desiderata. The elimination, or failing this, the subordination of all trolley and light poles on the deck of the bridge, was adopted as a policy which should be pressed consistently. The design of the hand-rail, the outstanding portion of the structure visible from the deck, remains. Since the observer views the handrail, not from a distance, as he views the arches, piers, and abutments, but at close range, the appeal to the imagination lies not so much in the tout ensemble, the grouping of the parts into a well balanced whole, as in the excellence of the parts themselves, the intricacy of the fabric and the quality of the texture. Hence it is essential that special methods of handling the concrete should be adopted so that the surface irregularities of commercial concrete, such as air holes, water holes, and form marks, would be eliminated. This may be accomplished in various ways, either by the dry process, or with sand moulds, or by scrubbing the surface of green concrete with steel brushes to expose a specially prepared color aggregate. On the Maryland bridge the third method was adopted; the colored aggregate consisting of red granite, crushed to pass a $\frac{3}{4}$ -in. screen, was exposed by scrubbing with steel brushes and cleaned by several washings of muriatic acid and water.

The illumination has been provided through the medium of four-light clusters, set on combination light and trolley poles, standing in the devil strip and located about 90 ft. apart. Each light is diffused by wide angle Holophone Refractors which reduce the glare materially; and the lights

would be equally unstable; hence the reason for the unusual foundations for these approach walls.

Assumed Loadings

Each arch was designed for a maximum live load of four 50-ton cars with an additional impact allowance of 20%. The arches have been so proportioned that under all conditions of loading the line of resistance lies within the middle third, resulting in a maximum compression of 453 lb. per sq. in. The maximum for combined live load, dead load, rib shortening, and a temperature drop of 60 deg. is 652 lb. per sq. in. and for a temperature drop of 60 deg., the maximum combined stress is 750 lb. per sq. in. For tensile stresses due to rib shortening and temperature, steel reinforcement has been provided. Details of the arch ribs and spandrel walls are shown in Fig. 2. In general, 1-in. rods were lapped 5 ft. at splices and $\frac{3}{4}$ -in. rods were lapped 4 ft.

The structure rests upon solid rock foundations. The abutments were designed with the line of resistance within the middle third and with a maximum pressure upon the rock of $9\frac{1}{4}$ tons per sq. ft. The rock was excavated to a depth of 6 ft. to provide additional resistance to sliding. The maximum bearing pressure from the pier upon the rock is 11 tons.

The spandrel walls were designed as cantilevers resting upon the arches, the moment from the side-walk brackets being transmitted through counterforts to the arch ribs. Expansion joints at the haunches provide for lateral movement resulting from the fall of the arches due to a drop in temperature, and at the third points expansion joints

predetermine the cracks resulting from the rise of the arches due to a rise in temperature. All joints have been projected to the handrails and appear to be working satisfactorily; those at the junctions of the handrails with the piers and abutments have opened approximately $\frac{3}{4}$ in. at this writing. All joints in the walls and side-walks have

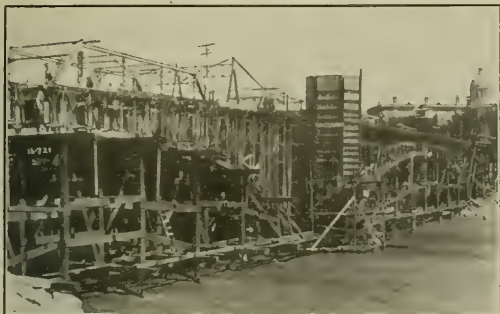


FIG. 3—EAST HALF OF BRIDGE UNDER CONSTRUCTION

been sealed by folded strips of sheet lead to prevent the escape of water through the joints with the attendant discoloration of the concrete.

Proportioning of Concrete

The proportioning of the concrete itself remains for consideration. The engineering department had been instructed to use the gravel and rock provided by the Greater Winnipeg Water District at a price of \$3.85 per cu. yd. for gravel supplied during the winter, \$2.00 per cu. yd. for gravel furnished during the summer, and \$4.00 per cu. yd. for crushed rock. The problem, stated simply, was to determine the economical proportions of cement, sand, rock, and water, combined to form concrete, which would give an assured compressive stress of 2250 lb. per sq. in. at 28 days, i.e., three times the maximum stress in the arches. Preliminary investigations disclosed the fact that there were wide variations in the physical characteristics of different samples of gravel from the same pit. Tests of the gravel showed that the weights per cubic foot varied from 98 to 115 lb., and the percentage of coarse retained on a $\frac{3}{4}$ -in. screen varied from 21% to 48%. Two series of tests were carried out, each embracing the making, and breaking in the testing machine of 60 cylinders 6 in. in diameter and 12 in. long. In the first series, the lighter coarser gravel, weighing approximately 100 lb. per cu. ft. was used. The materials were combined in one group to make one part of cement to six parts of the aggregate, such as 1:1½:4½, 1:2:4, 1:3:3, 1:3½:2½ and 1:4:2; and in another group to make 1:7½, such as 1:2:5½, 1:2½:5, 1:3:4½, 1:3½:4.

In the second series, while similar proportions were used, the gravel itself was more dense, weighing approximately 114 lb. per cu. ft. While no mechanical slump test for consistency was employed, the amount of water used was the least consistent with proper workability. The percentages of water for the first series varied from 6 to 8% by weight of the cement and aggregate, and the water cement ratio was from 0.58 to 0.86 by volume; for the second series the percentage of water varied from 7% to 9%, and the water cement ratio from 0.76 to 1.05.

Compression tests at 28 days showed that cylinders of the first series were approximately 22% stronger than cylinders of the second series composed of the same proportions by volume. Since prudence would dictate that we should base our decision upon the tests of the weaker of the two series, we concluded that the most economical combination from which we might expect to get concrete of the desired compressive strength was 1 part of cement to 3 of gravel to 2½ of crushed rock; while the best results for

the foundation concrete containing five sacks of cement to the yard were obtained with a combination of 1 of cement to 4 of gravel to 2 of rock. Complete records of the properties of the ingredients and of the concrete, were prepared and filed for reference.

Tests of Actual Concrete Used

In order to obtain assurance that the concrete in the structure was of the quality anticipated as a result of the tests, sample cylinders made of the concrete actually placed, were taken daily and tested at 28 days. The concrete placed in the substructure, containing 5 sacks of cement per yard, was very dry, of a consistency such that it would just quake under tramping. The average of the tests run during the months of February, March and April for this class of concrete was 2100 lb. per sq. in. at 28 days. The concrete in the approach walls, containing six sacks of cement per yard, was wetter than the foundation concrete, but with only enough water to permit spading and consolidating the mass in the thin walls. The average of the tests for the class of concrete placed during May and June was 2300 lb. per sq. in. The concrete in the arches containing six sacks of cement per yard was of a consistency such that it would not flow, while at the same time containing sufficient water so that it would quake upon being worked up. The average of the tests for the concrete in the arches at 28 days was approximately 2800 lb. per sq. in. The importance of keeping the water content of the concrete at a minimum consistent with workability was emphasized and impressed upon the construction organization, with the result that we were able to obtain a result which more than equalled our anticipations. The increase in strength from 2300 to 2800 lb. per sq. in. for concrete with the same combinations of solids but of different consistencies, is significant.

The proportioning of the handrail was the result of cut and trial methods, sample slabs having been prepared of different combinations of the aggregates; these samples, after having been scrubbed and washed, were placed side by side and compared. The proportion adopted was 1 cement to 2½ broken red granite to 1 granite dust to 1½ torpedo sand.

Construction Methods

The construction methods adopted for this work involved no spectacular operations. The prescribed task was the construction of the new bridge with a minimum of interference with the dense traffic over the steel bridge, the centre line of which was west of the new bridge with the floors of the old and new bridges overlapping.



FIG. 4—WEST HALF OF BRIDGE UNDER CONSTRUCTION—OLD STEEL BRIDGE REMOVED

The substructure of the abutments and pier were constructed as units; the superstructure, including arches, walls, side-walks, and fill, was constructed in two parts, the east half of the bridge having been completed and thrown open for traffic before the wrecking of the steel bridge, and the commencement of construction upon the west half. This

plan was adopted on the ground of economy, and because operations might be conducted under this method with the least interference with traffic. Figs. 3 and 4 show the construction of the east and west halves respectively.

The excavation of the abutments began in December, was carried out with the usual derrick and skip or bucket equipment and was expensive owing to the cold weather. In preparing the foundations for the pier, an orange peel was used to remove a surface layer of rocks and boulders; a line of Wakefield sheet piling was driven from leads suspended from a derrick boom; this piling was backed by a puddle, the combination affording an adequate water-seal whereby the water was kept down within the dam with a single centrifugal pump. In excavations for the abutments and approach walls, sufficient water was encountered to necessitate the continuous operation of pumps.

The concrete plant for the foundations included a paving mixer with a side-loading hopper for which extension leads had been prepared. In concreting the pier, this mixer was placed on cribbing at an elevation high enough to permit of dumping direct from the mixer to the pier; the cement, gravel and rock, placed in the loading hopper with wheelbarrows at ground level, were elevated to the mixer over the extension leads. In concreting the abutments, the mixer was placed on the ground near the edge of the excavation, the aggregate placed in the side loader with wheelbarrows, and the concrete conveyed through chutes to place.

The water and aggregate for concrete placed during the cold weather were heated; the spaces containing concrete were housed and heated for a considerable period after the placing of the concrete; every effort was made to give the concrete the advantage of being cured under conditions approaching normal.

Arches and spandrels were painted with a waterproof paint to increase their imperviousness.

Concrete Plant

The concrete plant for the superstructure consisted of a bin into which sand and rock were loaded from a bucket elevator, drawing from pits into which gravel and rock had been dumped, from heavy automobile trucks. This plant was so located in the west half of the north approach that it was possible to complete all concrete work without interference from the plant.

The concrete dumped from the mixer into side dump cars was drawn to place over a light wooden trestle by a small gasoline dinky, the engine for which had been taken from the mixer. In placing the concrete for the side-walk and spandrel walls, concrete buggies were drawn to place by the dinky on flat cars made in part of the trucks from the side-dump cars. The plant was cheap, eminently satisfactory, and the results were excellent.

The falsework was conventional, except perhaps, in the method employed to obtain the arch curve. In place of the standard practice of cutting the curves from the stringers, wedges and waste blocks and planks were added to build up the curves on plain stringers. Under this method much lumber otherwise worthless was used, and the stringers of new stock were available after use in a condition as good as that of new lumber.

Cinders for the fill were accumulated in an adjacent vacant lot during the first half of the year. These cinders were loaded into dump cars with a light electric Thew shovel and hauled to place on the bridge.

Construction began in December, 1920; the east half of the bridge was thrown open for traffic in August, the west half in November, and the street car traffic commenced on December 1, 1921.

The contract for the construction was awarded to the City Engineer, W. P. Brereton, on a competitive basis, at a price of \$250,000, and the bridge has been completed well within the contract price. The project was carried out with A. L. Cavanagh as superintendent; Allan Colman, chief draftman, and J. F. Green as consulting engineer.

SASKATCHEWAN ENGINEERS HOLD MEETING

AT THE annual meeting of the Saskatchewan branch of the Engineering Institute of Canada held at Regina recently, it was decided to hold meetings at Saskatoon during the year for the benefit of the members resident in the northern part of the province. The convention was well attended and the election of officers resulted as follows: Chairman, J. R. C. Macredie, Moose Jaw, district engineer for the C.P.R.; vice-chairman, C. W. Dill, Regina, superintendent of highways for the Saskatchewan Government; new members elected to the executive, R. N. Blackburn, Lieut.-Col. A. C. Garner and A. P. Linton, all of Regina; secretary-treasurer, re-elected, D. A. R. McCannel, city engineer, Regina. With the above the following old members complete the executive for the ensuing year: Prof. C. J. McKenzie, Saskatoon; J. W. Calder, Swift Current; G. W. Green, Moose Jaw.

The retiring chairman, W. R. Warren of the Saskatchewan Department of Telephones, gave a brief address, dealing with details in connection with the betterment of the institute and expressing thanks to the officers and members for their co-operation during the past year.

Votes of thanks and expressions of appreciation of the services rendered by the retiring officers and members of the executive were expressed. The three retiring members of the executive are H. M. Weir, Saskatoon; Lieut.-Col. A. J. McPherson, Regina, and C. W. Dill, Regina.

Speaking at the banquet held in the evening, Mr. Macredie expressed his appreciation of the honor conferred upon him by his election as chairman and briefly dealt with the past development and future prospects of the association. Mr. Dill also spoke briefly and in the course of his remarks pointed out the splendid opportunities which the future afforded to young men entering the profession, especially in view of the probable impetus which would be given the development of the natural resources as soon as they are turned over to the province for administration.

That building costs have been stabilized for at least one year, following negotiations conducted during the past few weeks by a special committee representing the various contracting and building concerns in Vancouver, B.C., was the announcement made at the conclusion of a meeting held recently by the General Contractors and Master Builders' Association of Vancouver. A comprehensive report covering the negotiations was submitted by the special committee, in which it was stated that with a condition of stability now assured the outlook for building this season is of the brightest.

Urging the necessity of a provincial good roads association, H. C. Carpenter, Deputy Minister of Highways for Saskatchewan, emphasized the educational value and said that such an organization must include all classes in the province. The importance of including the association of rural municipalities especially was mentioned, because its members spent more money on roads than the highways branch itself. In 1919 the department spent \$1,200,000; the rural municipalities \$2,100,000. In 1920 the department spent \$1,600,000; the municipalities \$2,800,000. In 1921 the department spent \$2,300,000. The figures for the rural municipalities for last year were not yet available, but would be in excess of the highways expenditures.

Recommendations contained in the report of the County Highways Committee that \$607,000 be spent this year in constructing and maintaining roads in Essex County, have been approved by the Essex County Council. Although the work will be financed by the county, \$293,000 will be provided by the province, leaving the county ratepayers to pay \$314,000. Only \$200,000 of the total amount can be raised by debenture issues, which means that \$107,000 will be paid this year in taxes.

WATER POWER RESOURCES OF CANADA

Review of Water Power Development—Power Utilized in Central Station and Pulp and Paper Industries—Many Water Powers Not Yet Developed

By J. T. Johnston,

Chief Engineer, Dominion Water Power Branch, Ottawa.

PRESENT activity in hydro power development warrants a further statement as to the extent of Canada's water power resources and as to the degree of their utilization. Last year has been one of substantial progress, there having been brought into operation new installation to the extent of 300,000 h.p. The installed water wheel capacity now totals to 2,763,000 h.p. with much new construction actually under way and many further enterprises in prospect.

During the past two years there has been under way in the Dominion Water Power Branch a careful re-analysis and computation of the water power resources of the Dominion. All existing stream flow and power data, available from Federal and Provincial sources, have been systematically collated, analyzed and co-ordinated with a view to preparing on a uniform basis from coast to coast, revised estimates of the power available. While the analysis is not yet finally completed, sufficient progress has been made to warrant the publication of the figures given herein.

The total available and developed power resources are presented in a manner not heretofore adopted. A consideration of the figures will indicate that they place the water power resources of the Dominion in a much more favorable light than have previously published compilations.

While the resources have been exhaustively analysed in so far as the information available will permit, it should be kept in mind that only very meagre data is to hand in many districts and for many rivers.

Basis of Computation

The figures for undeveloped water power listed in Table 1 are based upon rapids, falls and power sites of which the actual existent drop or the head possible of concentration, is definitely known or at least well established. Many rapids and falls of greater or lesser power capacity are scattered on rivers and streams from coast to coast which are not as yet recorded, and which will only become available for tabulation as more detailed survey work is undertaken and completed. This is particularly true in the more unexplored northern districts. Nor is any consideration given to the power concentrations which are feasible on rivers and streams of gradual gradient, where economic heads may be created by the construction of power dams, excepting only at such points as definite studies have been carried out and the results made matters of record.

In brief, the figures hereunder are based on definite rapids, falls and power sites, and may be said to represent the minimum water power possibilities of the Dominion.

The power estimates have been calculated on the basis of 24-hour power at 80% efficiency on the basis of "Ordinary Minimum Flow" and "Estimated Flow for Maximum Development." The "Ordinary Minimum Flow" is based on the averages of the minimum flow for the lowest two consecutive seven-day periods in each year, over the period for water records are available. The "Estimated Flow for Maximum Development" is based upon the continuous power indicated by the flow of the stream for six months in the year. The actual method to determine this flow is to arrange the months of the year according to the day of the lowest flow in each. The lowest of the six high months is taken as the basic month. The average flow of the lowest seven consecutive days in this month determines the maximum for that year. The average of such maximum figures for all years in the period for which data are available is the estimated maximum used in the calculation.

This estimated maximum development is based upon the assumption that it is good commercial practice to de-

velop wheel installation up to an amount, the continuance of which can be assured during six months of the year, on the assumption that the deficiency in power during the remainder of the year can be profitably provided from storage or by the installation of fuel power plants as auxiliaries. The correctness or otherwise of this assumption for any particular site can only be definitely settled by the careful consideration of all circumstances and conditions pertinent to its development. The method, however, enables us to make a fairly satisfactory over-all estimate of the maximum hydraulic power available, as distinctive from the estimated ordinary minimum power available.

The recorded power available throughout the Dominion, under conditions of ordinary minimum flow and within the limitations set out in the foregoing, is 18,255,000 h.p. The water power available under estimated flow for maximum development, i.e., dependable for at least six months of the year, is 32,076,000 h.p. (For details see Table 1).

TABLE 1
Available and Developed Water Power in Canada

Province	Available 24-hr. power at 80% efficiency.		Turbine installation h.p.
	At ordinary min. flow h.p.	At est. flow for max. dev. (depend- able for 6 mos.) h.p.	
1	2	3	4
British Columbia	1,931,142	5,103,460	305,315
Alberta	475,281	1,137,505	33,187
Saskatchewan	513,481	1,087,756	
Manitoba	3,270,491	5,769,444	104,147
Ontario	4,950,300	6,808,190	1,212,650
Quebec	6,915,244	11,640,052	1,015,385
New Brunswick	50,406	120,807	30,180
Nova Scotia	20,751	128,264	46,948
Prince Edward Is....	3,000	5,270	1,869
Yukon & Northwest Territories	125,220	275,250	13,199
	18,255,316	32,075,998	2,762,880

The figures listed in columns 2 and 3 in the above table represent 24-hr. power and are based upon rapids, falls and power sites of which the actual existent drop or the head possible of concentration, is definitely known or at least well established. Innumerable rapids and falls of greater or lesser power capacity are scattered on rivers and streams from coast to coast which are not as yet recorded, and which will only become available for tabulation as more detailed survey work is undertaken and completed. This is particularly true in the more unexplored northern districts. Nor is any consideration given to the power concentrations which are feasible on rivers and streams of gradual gradient, where economic heads may be created by the construction of power dams, excepting only at such points as definite studies have been carried out and the results made matters of record.

The figures in column 4 represent the actual water wheels installed throughout the Dominion. These figures should not be placed in direct comparison with the available power figures in columns 2 and 3 for the purpose of deducing therefrom the percentage of the available water power resources developed to date. The actual water wheel installation throughout the Dominion averages 30% greater than corresponding maximum available power figures calculated as in column 3. The figures quoted above therefore indicate that the at present recorded water power resources of the Dominion will permit of a turbine installation of 41,700,000 h.p. In other words, the present turbine installation represents only 6.6 per cent of the present recorded water power resources.

The above figures may be said to represent the minimum water power possibilities of the Dominion.

As illustrative of this the detailed analyses which have been made of the water power resources of the province of New Brunswick and Nova Scotia have disclosed most advantageous reservoir facilities for regulating stream flow and it is estimated that the two provinces possess within their respective borders 200,000 and 300,000 commercial horse power. These figures provide for a diversity factor between installed power and consumers' demands.

There are installed to date throughout the Dominion water wheels and turbines to the extent of 2,763,000 h.p. However, it would not be correct to place this figure in direct comparison with the minimum or maximum available power figures quoted above and therefrom deduce the percentage of the available water power resources developed to date. An allowance must be made for the average ratio between the water wheels installed and the power available.

An analysis of the water power plants scattered from coast to coast, concerning which complete information is available as to turbine installation and satisfactory information as to stream flow, gives an average machine installation 30% greater than the six month flow maximum power. Applying this, the figures quoted above therefore indicate that the at present recorded water power resources of the Dominion will permit of a turbine installation of 41,700,000 h.p. In other words the present turbine installation represents only 6.6 per cent of the present recorded water power resources.

Progress During Past Year

During the year 1921 the readjustment of values following war time inflation made substantial progress. This readjustment necessarily brought in its train many business and financial difficulties and the lack of confidence in trading circles generally led to a reluctance of capital to embark upon new enterprises. Employment fell off with a corresponding diminution in popular purchasing power and in consequence there has been a general tendency to mark time while readjustment advances the further step which will bring costs within the reach of the normal spending power of the community both individual and corporate.

The hydro-electric industry though naturally affected by the general depression suffered no set back and in fact the horse power installed during 1921, 300,000 h.p., stamps it as one of the most progressive years in Canadian water power history.

The progress of development is somewhat difficult to follow from year to year because the year is too short an interval. From three to five years or even longer often elapses between the first consideration of development and the delivery of power. Again most projects commence with an initial installation much less than the ultimate projected capacity and new units of machinery are installed from time to time as the load develops. In other words, what we may call the scoring column often does not reflect new construction for some years after such construction has been actively under way, but continues to record new scores from old developments.

The 300,000 h.p. installation during 1921 is made up of both kinds of growth and in addition a considerable amount of new construction was initiated which ensures that as old power plants reach their ultimate capacity new ones will take their place in maintaining the continued growth and prosperity of Canadian hydro-electric enterprise.

Developed Water Power in Canada

The 2,763,000 h.p. at present installed throughout the Dominion is apportioned to the following uses: (See Table 2).

2,013,000 h.p. in central electric stations for general distribution purposes, such as operation of street railways, operation of mines, operation of electro-chemical and electro-metallurgical industries, operation of pulp and paper mills and for general industrial and domestic use.

476,000 h.p. installed in pulp and paper mills. In addition there is used in the pulp and paper industry 161,000 h.p. purchased from the central electric station installations.

274,000 h.p. installed in industries other than central electric stations and pulp and paper mills.

The total installation for the Dominion averages 315 h.p. per thousand population, a figure which places Canada second only to Norway in the per capita utilization of water power among the countries of the world.

Water Power in Central Station Industry

By far the most important use to which the development of water power has been applied in Canada has been in connection with the central electric station industry. The extensive economic radius of modern electrical transmission, combined with the fortunate location of water power in relation to centres of industry, has resulted in the widespread development of the Dominion's water power resources through central electric stations. The extent of this industry and the important relationship which water power bears to it may be measured by the fact that 91% of the prime motive power is water power and that there is now invested some \$437,000,000 in hydro-electric plants and systems engaged in the production of electrical energy for sale and distribution.

Throughout the Dominion there are 282 hydro-electric stations with an installed turbine capacity of 2,013,000 h.p. or a generator installation of 1,701,000 k.v.a. (See Table 3). It is of interest to note that of the total turbine capacity, 1,449,000 h.p. is installed in commercial or privately owned stations while 564,000 h.p. is installed in municipal or publicly owned stations.

The units vary in size from 10 h.p. to the 60,000-h.p. turbines just installed in the Queenston development of the Ontario Hydro-Electric Power Commission and which are to date the largest turbines anywhere installed. The turbine units in the industry average 3,077 h.p. while the average installation of the central stations is 7,137 h.p.

Continued and systematic progress is being made in the further development of the industry; new units are being installed, new plants constructed and new projects investigated having in view the necessity for meeting the growing domestic and industrial demand for cheap hydro-electric energy.

Water Power in the Pulp and Paper Industry

The manner in which water power has influenced and assisted in the development of the pulp and paper industry throughout the Dominion is demonstrated by the power statistics of that industry.

Cheap motive power is almost as important to the production of pulp and paper as is the abundant supply of raw material. The importance of cheap power lies in the fact that it takes practically 100 h.p. to make a ton of paper per day. It is not therefore surprising that motive power used in this industry is practically restricted to hydraulic energy and that Canada's premier position in the pulp and paper field rests on adequate and abundant water powers well distributed among extensive forest reserves.

Throughout the Dominion 113 mills, operated by water power, are engaged in the manufacture of pulp and paper, using in all, hydro energy to the extent of 637,000 h.p. (See Table 1). This total is made up of 476,000 h.p. actually installed in pulp and paper mills plus 161,000 h.p. purchased by pulp and paper mills from central electric stations which derive their energy from water power.

The development of the electric drive in the pulp and paper industry has been marked in recent years. Its advantage lies in an assured uniform speed of operation and in the fact that it permits the centralized operation of a large mill receiving power from several hydro-electric sources. This means the economic location of pulp and paper mills having due regard for source of pulpwood supply, source of power supply and availability for shipping product. Of the 476,000 h.p. actually installed in pulp and paper mills, 179,000 h.p. is represented by hydro-electric drive. To this amount may be added the 161,000 h.p. of hydro-electric energy purchased from central electric stations, bringing the total electric drive up to 340,000 h.p.

TABLE 2.—DEVELOPED WATER POWER IN CANADA

Turbine Installation in H.P.

Province.	In Central Stations	In Pulp and Paper Mills	In Other Industries	Per 1000 Population	Total
1	2	3	4	5	6
British Columbia	207,656	48,800	48,859	305,315	584
Alberta	32,380	.....	807	33,187	87
Saskatchewan .....	.....	.....	.....	.....	.....
Manitoba	93,355	.....	10,792	104,147	170
Ontario	948,372	170,624	93,654	1,212,650	414
Quebec	696,593	224,412	94,380	1,015,385	432
New Brunswick	8,978	14,668	6,534	30,180	78
Nova Scotia	14,992	17,999	13,957	46,948	90
Prince Edward Is.	245	.....	1,624	1,869	21
Yukon	10,000	.....	3,199	13,199	3,170
Canada	2,012,571	476,503	273,806	2,762,880	315

Column 2 includes only hydro-electric stations which develop power for sale.

Column 3 includes only water power actually developed by pulp and paper companies. In addition to this total, pulp and paper companies purchase from the hydro power central stations totalled in column 2, 72,122 h.p. in Ontario and 88,455 h.p. in Quebec. The total hydro power utilized in the pulp and paper industry is therefore 637,080 h.p.

Column 4 includes only water power actually developed in connection with industries other than the central station and the pulp and paper industries. These industries also purchase blocks of power from the central stations totalled in column 2.

Column 5 totals all turbines and water wheels installed in Canada.

Column 6 averages the developed water power per 1000 population.

TABLE 3.—DEVELOPED WATER POWER IN CANADA UTILIZED IN THE GENERAL ELECTRIC STATION INDUSTRY

Province	Commercial Stations			Municipal Stations			Total			
	Installation			Installation			Installation			
	No.	Generator K.V.A.	Turbine H.P.	No.	Generator K.V.A.	Turbine H.P.	No.	Generator K.V.A.	H.P. per turbine Unit	Total Turbine H.P.
1	2	3	4	5	6	7	8	9	10	11
British Columbia	22	128,496	197,781	8	6,356	9,875	80	134,852	3,776	6,922
Alberta	3	22,250	32,380	.....	.....	.....	3	22,250	10,793	2,491
Saskatchewan .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Manitoba	3	11,063	26,255	1	57,000	67,100	4	68,063	4,913	23,339
Ontario	73	408,823	493,334	44	483,479	455,038	117	892,302	3,248	8,106
Quebec	80	546,316	678,778	15	13,238	17,815	95	559,554	3,210	7,333
New Brunswick	7	6,100	8,168	2	476	810	9	6,576	528	998
Nova Scotia	7	1,196	1,583	10	9,684	13,409	17	10,880	750	882
Prince Edward Is.	6	307	245	.....	.....	245	6	307	35	41
Yukon	1	6,000	10,000	.....	.....	.....	1	6,000	5,000	10,000
Canada	202	1,130,551	1,448,524	80	570,233	564,292	282	1,700,784	3,077	7,137

Commercial Stations include all privately owned.

Municipal Stations include all publically owned.

NOTE—Statistics in this table are based upon a Census of the Industry made by the Dominion Bureau of Statistics in co-operation with the Dominion Water Power Branch.

TABLE 4.—DEVELOPED WATER POWER IN CANADA UTILIZED IN THE PULP AND PAPER INDUSTRY

Installed and Purchased Power: H.P.

Province	No. of Mills.	Turbine Installation in the Industry			Purchased Hydro-Electric Power	Total Hydro- Electric Col. 4 & Col. 6	Total Utilized in the Industry Col. 5 & Col. 6
		Direct	Drive	Total			
1	2	3	4	5	6	7	8
British Columbia	5	27,975	20,325	48,800	.....	20,825	48,800
Ontario	41	89,430	81,194	170,624	72,122	153,316	242,746
Quebec	54	159,900	64,512	224,412	88,455	152,967	312,867
New Brunswick	3	2,368	12,300	14,668	.....	12,300	14,668
Nova Scotia	10	17,919	80	17,999	.....	80	17,999
Canada	113	297,592	178,911	476,503	160,577	339,488	637,080

Column 2 includes all turbines actually installed in the industry and directly driving mill equipment.

Column 4 includes all turbines actually installed in the industry and transmitting power through electric drive.

Column 5 totals the turbine capacity actually installed in the industry.

Column 6 includes only power purchased from hydro-electric central stations for the operation of pulp and paper mills.

Column 7 totals the hydro-electric power used in the industry. Column 8 totals the water power used in the industry.

Of the total installation listed, 5 mills are located in British Columbia utilizing 48,000 h.p., 41 in Ontario utilizing 242,700 h.p., 54 in Quebec utilizing 312,900 h.p., 3 in New Brunswick utilizing 41,700 h.p., 10 in Nova Scotia utilizing 18,000 h.p.

The systematic progress during the past few years in the pulp and paper industry is an indication of the rapid expansion which may be expected in the future.

Future Growth in Utilization of Water Power

It is profitable to consider the history of water power utilization in Canada during the past few years in conjunction with the present activity with a view to making some reasonable forecast as to its probable future growth. Should the rate of water wheel installation during the past fifteen years be maintained, there will be installed in 1925, 3,360,000 h.p.; in 1930, 4,110,000 h.p.; in 1935, 4,860,000 h.p. and in 1940, 5,600,000 h.p. In view of the increasing appreciation of the advantages of hydro power combined with the fortunate location of ample supplies within easy transmission distance of practically every great industrial centre throughout the Dominion, there is every reason to anticipate that this rate of growth in utilization will be accelerated rather than retarded. Reference to the foregoing totals of water power available will indicate that this anticipated increase in utilization will not seriously reduce the total reserves. Canada possesses sufficient reserves of water power to meet all anticipated demands for many years to come.

In order to ensure the most beneficial utilization of these reserves and to provide intelligent guidance for their development, two essentials are required:

1st: An accurate knowledge of the location, capacity and the engineering and economic possibilities of development of the water powers throughout the Dominion, together with their relationship to other natural resources of mine and forest, to industrial centres and opportunities, to transportation systems—rail and navigation, to coal and fuel supplies, to irrigation, drainage and reclamation projects, to alternative sources of power and to market for and uses of power in general.

2nd: A sound governmental administrative policy designed to protect the public from inadvisable and ill-designed power schemes and to provide for reasonable regulation and revision of rates and rentals, and at the same time to ensure satisfactory guarantees for the encouragement of legitimate investment in hydro power enterprises.

True conservation of our water power resources, which are inexhaustible through use, lies, not in withholding them from development, but in their efficient utilization in the public interest for the economic exploitation of our other natural resources, and for the conservation of our exhaustible fuel supplies.

The water power now developed in Canada represents an investment of \$530,000,000. In 1940 should the rate of growth of installation during the past 15 years be continued, this investment will have grown to over \$1,000,000,000. The present development represents an annual equivalent of 20,500,000 tons of coal which, valued at \$8 per ton, represents \$164,000,000. In the year 1940 these annual figures will, with the foregoing assumption, have become 42,000,000 tons and \$336,000,000. These figures are striking evidence of the outstanding importance and necessity of an intelligent administrative policy governing the development of our water power resources.

AGENTS FOR IRVING IRON WORKS

ANNOUNCEMENT is made of the appointment of the Standard Steel Construction Co., Welland, Ont., as sole Canadian representatives for the sale of the products of the Irving Iron Works, New York City, consisting of steel floor-gratings and "Safesteps." Irving floor gratings have been used almost exclusively in the subway work in New York and vicinity.

CHILEAN RAILWAYS TO BE ELECTRIFIED

AN IMPORTANT contract was recently awarded to the Westinghouse International Co., by the Chilean Government for the electrification of the first zone of the Government steam railways. This contract which is one of the largest and important single orders received by any firm on this Continent will amount to \$7,000,000 and will include electrification of 146 miles of road, 39 locomotives and five sub-stations.

The total railroad mileage of Chile is 5,200, of which about 30 per cent is privately owned mainly for mining and industrial enterprises. The remainder of the mileage is divided into two general classes, the broad gauge lines and the narrow gauge lines. The former extend South from Valparaiso by way of Santiago to Puerto Montt, with numerous branches, while the latter comprise most of the northern roads with a few branch lines in the South.

The initial electrification will include 116 miles from Valparaiso to Santiago, and 28 miles from Las Vegas to Los Andes. Los Andes is the terminus of the Transandine Railroad, a narrow gauge line, while the narrow gauge longitudinal railroad runs north from Calera, an important station on the line to be electrified. The line contains a relatively large number of curves, the maximum being 10 deg. The track gauge is 5 ft. 6 in. There are six tunnels on the main line, the longest, the San Pedro, being 1600 ft. in length. Three of the tunnels are located on the most severe grade approaching the Summit.

Long Transmission System

The 300-volt direct-current system was decided upon as best suited to the conditions. Hydro-electric power will be generated at the Maitines Station of the Chilean Electric Tramway Line Co. This station is already under construction and will utilize the waters of the Rio Colorado. The station will contain three 8125-kva Westinghouse generators and will have an ultimate capacity of 30,000 kw. This power will be transmitted 37 miles to Santiago by twin circuit 110,000-volt transmission lines and will be generated at 50 cycles, 3-phase. These transmission lines will be connected at Santiago with the system fed by the Florida hydro-electric station and the Mapocho steam station, both of which were constructed some years ago by the Germans and were designed for 50-cycle 3-phase power. The total capacity of the three generating systems at present proposed will be, when completed, approximately 120,000 kw.

The power supply will be distributed by five sub-stations designed to handle a train movement that is approximately 50 per cent greater than that existing in 1917, with a further provision for tripling the 1917 traffic demands, if necessary. Each station will initially contain two Westinghouse 2000-kw. motor generator sets, each set consisting of a 2300-h.p. driving motor, and two 1000-kw. 1500-volt generators connected in series. These sets will be designed to withstand a 200 per cent overload for five minutes without injury, and as an additional safeguard the dash suppressor which the Westinghouse Co. has developed, will be included.

Sub-stations Nos. 1 and 5 will receive power at 12,000 volts, while Nos. 2, 3 and 4 will receive power at 44,000 volts. Transformers and switching equipment will be of the Westinghouse latest design and the Westinghouse developed power indicating and limiting equipment will be installed.

Thirty-nine electric locomotives are required for the initial electrification, including 6 express passenger, 11 local passenger, 15 road freight and 7 switching locomotives. All locomotives will be equipped with Westinghouse motors. The express passenger and road freight locomotives will be equipped with the Westinghouse system of regenerative braking, with the most modern development. The service in which the local passenger locomotives will operate will not require or justify the regenerative braking feature.

HOW SHOULD PROVINCIAL HIGHWAYS BE FINANCED?*

Distribution of Responsibility — Who Should Pay For the Highways? How Should They Be Paid For?

By F. H. Richardson,
Warden of Ontario County.

THE determination of the location of the provincial highways in Ontario was governed largely by our urban centres and their requirements as to transportation. That was practically the sole force that determined the location in this province and was only affected by a consideration of the tourist traffic which has become very important to the province. So far as the requirements of purely rural districts or the wishes of the rural districts in this province were concerned they did not affect the location of one mile of provincial highway. When we consider the matter of the main highways of this province in regard to transportation there is no doubt the proper considerations were given as to the locations of these. When you come to our rural districts and consider their road requirements, they call for market roads, roads to the station and roads to the village which are of great importance. Comparing the mileage of provincial highways with the tremendous road mileage of the province, there are only a few farmers who will use the provincial highways in the general run of their business.

Channels of Transportation

On the other hand the provincial highways have become an important factor in extending communication between our urban centres. There is no question that the main highways such as the county, county-provincial and provincial, have become through the motor traffic, the important channels of transportation of this province, and cannot be considered in the same category as a city street or the concessions and sideroads in rural districts. And there is no doubt the up-keep develops upon the cities, upon the counties and upon the province; the only question is the equitable distribution of the responsibility. Some of these roads have been under the control of the province, some under the county councils and some under what are known as Suburban Area Commissions. We have heard the argument that because the province has taken over certain roads as provincial highways therefore the province should undertake the entire cost. The same argument can be used in a suburban area, that because the Suburban Commission has taken over a certain road therefore that district should carry the entire up-keep, and so with county roads. There is no logic in this argument and to my mind it is nothing more or less than subterfuge to evade responsibility.

I did not intend to take much time referring to the dozens or hundreds of deputations that waited upon the Provincial Government to urge that certain highways should be designated as provincial highways. There is no question that they would be a great advantage to the people who were pleading that these roads be made provincial highways but not to the other fellow. Now then you find these cities and districts through which the highways run asking to be relieved of the responsibility, to say the very least, it is unfair to the other part of the province, and certainly is against that principle of taxation which from time immemorial has been recognized as just, namely that the districts or communities that receive the benefits should pay. Now I think our county road system helps us to decide who should pay for these provincial highways. We can all remember the advent of motor cars and the condition of our main highways throughout this province. The Provincial Government for the purpose of improving and taking care of condi-

tions recommended the county road system which was started by our urban centres. The rural districts were loathe to take hold at first, however we have that system.

How Roads are Financed in Ontario County

The province aids and the towns in the counties pay the same toward these county roads as the rural districts; the county councils may vote on roads that are connecting links in the towns a certain amount to help the town out. It works out in the County of Ontario in this way: Since we adopted the county road system we have assessed our county for road rates to the extent of two mills. We have been giving back to our towns half a mill. The towns in the County of Ontario appreciate the object of the highway legislation, that is, that the urban centres should recognize and help in keeping up these main highways and I might say that the towns in the County of Ontario have always been pleased with that condition. The Town of Oshawa pays one-seventh of the cost of the good roads in the County of Ontario and we reach up to the Muskoka district.

When you come to the cities they do not pay towards the county road but towards the suburban area comprising provincial highways and other selected roads. If the cities could evade their responsibility towards the provincial highways you would find a few cities in the province doing so and not commencing to help to keep up the good roads the same as their neighbors in the towns throughout the province. For the cities to evade their responsibility would destroy the fabric of the good roads movement by which we all hope to have good roads in this province.

We must not forget that two or three years ago there was great opposition to the provincial highways because they only ran along the north shores of Lake Ontario and Lake Erie, and the great mass of the people of Ontario were not receiving any benefit. Even today although they have been extended four times their length yet it must be apparent to everybody, for the districts enjoying the advantages of these highways to evade or have their responsibility cancelled, would result in one or two things. You would create great opposition to the provincial highways on the one hand or on the other you would have all the counties in Ontario clamoring to have their highways made provincial highways in order to evade responsibility.

A provincial highway running through a county is the main highway of that county, and there is no question that it will draw to it a great deal of traffic, thereby relieving other highways in the country and thus relieving our local municipalities and other counties of considerable cost. We do not want to blind ourselves to the fact that the construction of roads costs money and an organization, whether county or city council, who wants roads, can only get them by dealing fairly with one another.

Viewpoint of Province

Let us look at the other side of it, that of the province. We must not forget that the obligation of the province is tremendous, that the amount of money that they are spending on the roads is a source of considerable criticism, political and otherwise, not only in the government but throughout the province. The province gave to counties and suburban areas last year somewhere in the neighborhood of \$5,000,000, without taking care at all of the expenditure on the provincial highways. When we consider their source of revenue for this purpose, namely, motor vehicles, 20% assessment on cities and counties, and the grant from the Federal Government, we know that the balance of the money must come from the consolidated revenue fund of the province and we all know that the taxes are up to the limit for that purpose. There is no doubt the province has gone their limit and if they were to concede to the cities their request it would create an injustice between urban and rural centres in the building of highways in the province. There is too much made out of the opposition to the cost of provincial highways. We in the County of Ontario have taken this position: We have recognized that the construction of the provincial highway is of a per-

*From paper read at Twentieth Annual Meeting of Ontario Good Roads Association, March 2.

manent nature and when the road is built, the future cost will only be that of maintenance and a burden to nobody; therefore, our county considered it was only fair and just that we should issue bonds to help us carry over the 15-year period, with the result that it is not costing the taxpayer of the County of Ontario any more to construct the provincial highway than any other of their system of roadways, and the people of our county are satisfied and pleased with the work that has been going on.

Toronto Not Helping Provincial Highways

I would like to take this opportunity of dealing with this question so far as it applies to the City of Toronto. The force that created the agitation for the building of the Toronto-Hamilton Highway in the first place emanated from the city of Toronto. Then Hamilton took hold of it and they worked on it and pleaded for it until they got the municipalities between here and Hamilton to arrange to build it. Legislation was passed to carry out the construction of that highway. At the same time the city of Toronto came down to the district to the East and agreed to pay 30% of the cost of a similar road to meet their requirements between Toronto and Oshawa, however, this did not materialize as road building then took an impetus throughout the Province of Ontario and an agitation took place for Provincial Highways. So the outcome of the work of the city of Toronto gave rise in reality to what is known as our Provincial Highway system today. In that the city of Toronto recognized her responsibility, recognized the necessity of these improvements for herself, she went out pleading for them and had a perfect right so to do. The provincial highway legislation today, is on the same basis only more favorable to the city, more favorable to the counties than the basis on which you of the city of Toronto strove to build the Toronto-Hamilton Highway and on which the proposed road between Toronto and Oshawa was to be built. I want to place before the people of Toronto that by their acts they recognized the justice of the provincial highway legislation so far as their responsibility is concerned; they recognized the necessity of this work. Now I want to say further the city of Toronto today is not a party to the provincial highway system, although she is paying on the suburban area. Toronto probably enjoys this position of isolation. Toronto is the only big city, I believe she is the only city in the Province of Ontario, that is not helping so far as the provincial highways are concerned. She is doing less than any town in the province. This is unfair, and I want to say this to the Minister of Public Works and the City of Toronto that we in the suburban area have something to say and if this question is not quickly settled we will get together and have something to say in what Toronto's responsibilities are and they shall be carried out.

The country needs all kinds of transportation, and transportation means prosperity not only to the city but to the rural districts as well. You can have no prosperous rural district without transportation and the City of Toronto must be connected up with the finest system of transportation she can get to gain the greatest benefit. I believe the province is being fair with the local districts. They are getting the provincial highways for 20% and I believe our advantage is equal to that and we should not try to evade it; we should not hamper the province in its good work so far as roads are concerned.

ROAD BUILDING IN THE U. S.

FEDERAL road construction in the United States during 1922 will expand in every section of the country as a result of the amount of money made available by the Federal Government and because of the conditions of reasonably cheap materials and plentiful labor. At the beginning of this year an additional \$73,125,000 was set aside as federal aid to highway construction, all of which, according to the stipulations accompanying this grant to the various state governments, must be expended by June 30, 1924, while the balance of the previous aid grants must be expended before June 30, 1923.

New York State's total apportionment under the new act is \$3,696,447, of which \$2,464,000 became available at the beginning of the year. Under the old acts, New York has been allotted \$13,688,801, which, with the appropriation under the new act, makes a total of \$17,385,249 which the United States will have contributed to the State's system of highways. Texas, on account of her area and mileage or rural and state routes, receives a total of \$20,000,000.

Six Million Tied Up

Of the \$13,688,801 allotted to New York, more than \$6,000,000 is tied up in completed work or highways under construction, more than \$7,000,000 is available for new construction, only \$3,000,000 is in entirely completed work, and \$1,189,523 had been earned by the State. Until five years ago the Federal Government took no hand in road construction. Today half the roads being built are being aided by the United States.

What the new legislation will mean to the country can be judged by the way in which the \$275,000,000 previously appropriated has been spent. Practically \$200,000,000 had been put to work up to the time the last report was completed, and to match this the States appropriated a total of \$265,000,000, making a grand total of \$465,391,000. The total mileage of roads involved was 28,000.

Restrict Heavy Loads

Officials of the Bureau of Public Roads of the Agriculture Department say that next to construction of roads the prime problem is to work out regulations for the use of unusually large trucks because of the wear and tear they impose. One way to solve the problem, they say, is to restrict their use to certain highways designed to accommodate them. Another way would be to strengthen all roads, and the third to prohibit the use of these trucks entirely.

For the security of the enormous investment which is being made by the States and Federal Government, it is imperative that this question of the duty which the roads will be called upon to render in the future shall be definitely determined. A clearer conception of the relative economy of heavy and light vehicles will be gained by careful study.

The bureau is now making investigations to determine accurately the load carrying capability of various kinds of roads, of various thicknesses upon different kinds of subsoils, and the variance of traffic in different localities. In one State it is claimed that the return from the roads in reduction of transportation costs and development of territory undoubtedly has compensated for the loss resulting from their destruction by the trucks.

In line with its recent action in opening branch offices at Raleigh, N.C., with Harry P. Grier in charge, and at Atlanta, Ga., with James R. Valk in charge, the Asphalt Association, New York City, J. E. Pennybacker, secretary, carrying out its policy of expansion, has moved its Canadian office from Toronto to Albany, N.Y., where Germain P. Graham, formerly deputy city engineer of Albany, will be in charge as district engineer. Mr. Graham will not only look after the Asphalt Association's interests in Canada but will travel the state of New York, assisting street and road engineers and contractors wherever necessary, in solving such problems as they may encounter in asphalt work. This service will be rendered to counties and municipalities free of charge. Mr. Graham graduated from Rensselaer Polytechnic Institute in 1908 as a civil engineer. From 1909 to 1917 he was in the city engineer's office at Albany where he had charge of individual construction jobs such as the river front improvement and the field work in connection with the intercepting sewer. During the World War he served as Captain and Adjutant in the Twentieth Engineers, and after the signing of the Armistice was put in charge of road repair work in Southern France. At the conclusion of his army service he returned to Albany as deputy city engineer.

ASSESSMENT FOR BENEFIT*

Highway Construction Improves Value of Property — Assessments Should Be Increased — Plea for Legislation to Encourage Proper Assessment

By K. W. McKay,
Clerk of Elgin County, Ontario.

IN THE development of the highway laws of the Province of Ontario every care has been taken to provide for the equalization of benefit and expense; to provide roads for everyone to use, and to equalize the expense as far as possible, that was the trend of the legislation. It has been said that we derive a great deal of benefit by the increase in property values due to good roads, and dealing with that phase of the matter I want to direct your attention to two very simple matters that county councillors and their officers are overlooking every year. One of these matters relates to the assessing of property along, or contiguous to an improved highway. A few years ago a friend of mine who had a market garden on the Toronto-Hamilton Highway of 40 acres that he had purchased for \$8,000, was able to sell it after the highway was constructed for \$40,000, making a profit of \$32,000, and he is able to live in comfort now.

A year or two ago we investigated the effect that an improved highway had on the assessment of property, and we found that along the Toronto-Hamilton Highway there was no appreciable increase in assessment and in some cases the assessment had been decreased. That in itself would suggest that municipal officers were not doing their duty in that particular township. No one will deny but that there is an added benefit by the building of an improved highway, and that added benefit should be considered by the assessor; if that is not done there is a considerable discrimination in favor of the property along the improved highway, and it has the effect of making the man in the back part of the township, furthest away from the improved highway, make the same contribution in township taxes. I think the township council should bring matters of that kind to the attention of their assessors. It is just possible that the owners of property along these improved roads are influential men, and that is all the more reason why they should be made to pay on the improved values of their property.

Province Should Appoint Inspector of Assessment

That is one way in which township councils can, under the present law, encourage assessment for benefit. The next way in which that can be done is in the county council. We all know that the county councils equalize the assessments annually, and when the valuers are being appointed there is generally considerable wire pulling and log rolling before their report is adopted. I would suggest that in the future the county councils should consider the location of improved highways in making their equalized assessment, and see that the township values are increased in cases where there are improved highways, unless that is done it is difficult to get a proper contribution. It is well enough to direct attention to a matter of that kind, but in order to have a law of that kind enforced, it will be necessary to have additional legislation and that additional legislation should be with the view of encouraging proper assessment of all lands along improved highways. My suggestion is that the province should appoint an inspector of assessments along improved roads and that the duty of such an inspector should be to see that the added values are properly assessed.

The bill prepared for consideration in 1916 provided for a system of assessment for benefit, and that engineers should go over the property and determine what increase in value had been added to each property by the building of the highway, and make a report similar to the report that is made under the Drainage Act; the township council to

constitute a Court of Revision for the adjustment of the benefit as determined by the engineers' report. The question of the amount the property along the improved highway should be charged is another matter.

Provision on Provincial Highways

In the construction of provincial highways the law provides that the county shall pay 20% of the cost, and I think the same thing should apply in connection with county and provincial county roads; that the municipalities through which they are constructed should pay 20% of the cost and that the township should assess a portion of that against the land fronting on the highway. The principle of charging the county 20% for provincial highways is I think a proper one. There always comes a day of settlement and in the end the people have to pay.

In some counties they are having difficulties in meeting the wishes of the people who live along suburban area roads, and in connection with provincial highways through police villages. In localities like that they generally want a wide road, the ratepayers are all in favor of the wider highway and they would like to do the work on the local improvement plan, a police village is part of the township and the local improvement act does not apply and I think it should be amended so as to cover cases of this kind. I think the further consideration of all these matters should be referred to a small commission who could report fully.

Toronto-Hamilton Highway Case Cited

A short time ago there were some expropriation proceedings in connection with the Toronto-Hamilton highway, and the department appealed from the decision of the arbitrators, claiming that the property derived a great deal of benefit from the work as a whole and that that should be set off against the damage; the department is of the opinion that there is a large added value and how to arrive at that added value should be something for the commission to consider. I believe that in all matters of highway construction whether county, provincial or township, that where it is necessary to expropriate property the township or county authorities should be allowed to act immediately, the same as the provincial authorities can act and take possession of the property immediately and leave the assessment of damage if any to be settled afterwards.

We hear a great deal about private approaches; I do not think the same idea is applied in any two counties. I have given a good deal of attention to this matter and while we may not agree on the question it is perhaps well to understand what some people may think of it. Our county road superintendent had some difficulties in convincing the ratepayers that the old box culverts that he had taken out in front of farm gates should not be put in again by the county. He had been advised that the county was not liable and in order to get a clear and distinct reason for his action he submitted the whole question to the county solicitor who advised him that the county was only liable when the damage to the property as a whole was greater than the benefit that property derived from the work.

I think that is all I can say at the present time with reference to assessment for benefit except to suggest that a commission be appointed to consider the whole question and have a proper report laid before this association or the legislature at the next session and I think such a report would surprise you as to the condition of affairs at the present time.

In the discussion which followed, Daniel Quinlan, treasurer of County Simcoe endorsed the remarks made by Mr. McKay. In many of the counties of the province, particularly the smaller ones there may be direct benefit derived by every ratepayer in the county from the provincial highway, but in some of the larger counties, particularly where the provincial highway does not run through the centre of the county there is no very great benefit to a majority of the ratepayers. In the County of Simcoe a large part of the ratepayers receive no benefit from the provin-

*Paper read at Twentieth Annual Meeting of the Ontario Good Roads Association, Toronto, March 2.

cial highway. We have 30 municipalities and I venture to say that more than 50% of the ratepayers live more than 20 miles from the provincial highway, and some of them live 30 and 40 miles away from it.

SOME ASPECTS OF ONTARIO GOOD ROADS MOVEMENT*

Defends Large Expenditure—Good Construction Record in Ontario—Importance of Township and County Roads—Statute Labor Being Eliminated

By W. A. McLean

Deputy Minister, Ontario Dept. of Public Highways.

THERE are a few features of our work which appeal to me very pointedly and which I would like to discuss. One is that I have not at any time been able to see the unanimous opinion that the time was ripe to pay for the construction of good roads. Everybody wants good roads but there is always a fear that they should be called upon to pay for them. So long as I see the enormous waste going on throughout the country, I have no fear whatever that insolvency will be created through the construction of good roads. Enormous sums are spent for pleasure, a great deal more than we are spending for the construction of good roads. Fire alone in the Province of Ontario consumes as much almost as we are spending on good roads. Waste is going on in every direction, and if we could sum up these wastes we would be appalled. When men tell me that we are going to handicap ourselves by the construction of good roads I say he has a wrong view, otherwise the country would have disappeared long ago. It is astonishing the amount of waste the country can stand; it is impossible to explain it, but when we go ahead on real construction, creating assets of a permanent nature and of real value within reasonable limits of cost, we are on absolutely safe ground.

Three Departments of Highway System

We have divided our highway construction into three parts, township roads, county roads and provincial highways. We are apt to give too much prominence, I think, to the provincial highway system. It is something new, and it is for a short time absorbing a large expenditure; but it after all is only one department of our highway system, all the others are equally important, and I have been very much in sympathy with an effort to improve township roads, and there is no branch of our work in which I am more keenly interested. If you include colonization roads we have in Ontario about 30,000 miles of surfaced roads, and in Southern Ontario we have about 27,000 miles of surfaced roads. If the United States could equal that, in proportion to their population, they would have about 1,000,000 miles of surfaced roads but they have only slightly over 500,000 miles. Ontario, in proportion to population is holding her own well in the construction of good roads, and I attribute this work to the superior municipal organization that we have in Ontario as compared with other places. That is a fact which I do not think the people of this province appreciate. We have in Southern Ontario about 23,000 miles of gravelled roads. They are not all of high class construction, and they are not all maintained as they should be, but they are gravelled roads that you can get over at any season of the year, and they are vastly superior to the mud and sand roads which would otherwise be in use.

Extend Township Roads

The important thing for the townships to do is to extend these roads as fast as they can, but in the meantime save what you have got. I hope that a considerable part of our effort in the future will be toward the encouragement of more efficient management of town-

ship roads in order that the surface that you have may be improved and kept in use, and that the surfaced township roads may be extended. We help, it is true, by a provincial grant but I expect and hope for almost more from the influence that our inspecting engineers will have in going around among you, meeting your officials, and meeting the township councillors, guiding and advising with them as to how they should do their work. I hope that every township will, as fast as it can, organize and create a system for the dragging of their roads so as to keep the township roads, the gravelled roads, in as good condition as possible. I hope you will adopt improved plans of grading in order that when you put on a surfacing it will be on such a grade that it will stay on the road. We hope that in a short time every township will have a superintendent in charge of the work.

I am told by our engineers that since we initiated legislation towards this end that the tendency is strong in favor of commuting statute labour or doing away with it entirely and putting the work in charge of a superintendent. That is one of the most useful steps that a township can possibly take. It will not do to simply abolish statute labour and it will not do to simply commute it, the main factor is to see that the work is carried out systematically through a permanent road superintendent, along the lines that this association has advocated for many years. From the report of our engineers, I can say that all these things are coming along very rapidly, and I understand that about 60% of the townships have done away with statute labour.

Township and County Roads

The county road systems have been with us for many years and the are becoming an old thing with you. At one time they were new and the organization which you required was something which was of the keenest interest to this association. In my opinion the county road plan has reached the stage where they can fairly operate within themselves, and I hope that the Ontario Good Roads Association will take a keen interest in bringing the township roads up to the standard, so that when the provincial highways are completed, and the county roads well under way, we may have the full use of all this work by means of secondary roads, the township road, reaching out to every farm.

As I have indicated the provincial highway is at the present time absorbing a good deal of interest, in part because of the heavy expenditure. In one or two years the heaviest part of that expenditure will have been completed and from that time on we may expect to have an extension and a further development of the provincial highways, but the main features of the provincial highway will have been established, and it will become the least important of the system of highways for this association to consider. You will always have the township and county roads to improve. Our organization is now such that for every seven or eight townships you have a district engineer who is at your disposal for consultation, and I hope you will make good use of him. We want you to put yourselves in touch with him if he is not in touch with you, and what you cannot get from him we hope you will ask the central office for. We are here at your service eager to aid and help this big work of highway construction and improvement throughout Ontario.

The principal mineral producing province of Canada, according to the returns for 1921, was Ontario, where the value of mineral production was \$54,505,770. British Columbia came second with a mineral production valued at nearly \$35,000,000. Nova Scotia was a close third, with \$32,500,000. Alberta ranked fourth, with \$29,000,000. Quebec was fifth, with \$14,600,000, and Manitoba, Yukon, New Brunswick and Saskatchewan followed in the order named with productions between one and two million dollars each.

*Address before Twentieth Annual Meeting of Ontario Good Roads Association, Toronto, March 2.

ANNUAL MEETING OF THE TORONTO BRANCH, E.I.C.

THE PROGRAM of the Toronto branch of the Engineering Institute of Canada for the present session was brought to a conclusion on Thursday evening, March 16, when the annual meeting was held. Reports of committees were received and discussed and the new officers were installed for the ensuing season.

Geo. T. Clark, in making his retiring address, pointed out that the branch had been successful in wiping out an old financial obligation of \$199 to the Engineers' Club for bookcases and work done in connection with the library. The sum of \$125 has been advanced to the Library Committee for necessary improvements and an honorarium of \$100 each to the secretary, and to the preceding secretary has been paid. He spoke hopefully of the campaign for protective legislation in Ontario and highly commended the work of Willis Chipman and Col. H. J. Lamb in this regard.

The secretary-treasurer, F. B. Goedike, reported a cash balance in the bank of \$374.25, with an outstanding cheque of \$125, thus making a surplus of \$249.25. Col. H. J. Lamb, chairman of the Finance Committee, confirmed the report of the secretary-treasurer.

In commenting on the report of the Membership Committee the chairman pointed out that a considerable number of students who had applied for membership a year ago had not accepted their election and paid their fees, so that the actual membership of the branch is under 500. Had all those who were elected accepted their election, the membership would have been at least 650.

C. R. Young, chairman of the Publicity Committee, reported that every effort had been made to secure favorable mention of the activities of the branch in both the daily press and the technical press, and that on the whole the results had been satisfactory. J. M. Oxley, in discussing the report, deplored the fact that the daily newspapers almost always neglect to give the names of the engineers connected with a piece of work that is being described. T. D. Mylrea, chairman of the Committee on Ethics, reported that the work for the year had not progressed as rapidly as was hoped on account of his being unable to give much personal attention to the subject.

J. M. Oxley, chairman of the By-Laws Committee, described the work that had been done in preparing amendments sent out to the membership for adoption by ballot.

H. L. Seymour, Chairman of the Town Planning Committee, reported recent progress with respect to town planning in this district.

T. L. Crossley, chairman of the Committee on Sociology, reported progress pointing out that one meeting under its auspices addressed by Professor J. A. Dale had been held.

R. O. Wynne-Roberts, chairman of the Reception Committee, urged that every effort be made to assist the committee in obtaining the correct addresses of the members.

A. C. Oxley, chairman of the Library Committee, outlined the use to which the grant of \$125 was being put. The proceedings of the American Railway Engineering Association were being brought up to date and a number of valuable text-books were being added to the library. In discussing the report of the committee, G. G. Powell urged that an appraisal of the books owned by the branch be made for a possible increase in insurance. Frank Barber expressed the view that the insurance was not enough and that not enough money was being spent on the library. The resolution was finally carried, referring the matter of appraisal and extension of the library to the new executive.

R. T. G. Jack, chairman of the Committee on Employment, reported that on account of the lack of work in the engineering field, employers had not been able to offer any positions to which members out of work could be sent.

J. M. Oxley reported that as special representative of the branch on the committee appointed to consider the Lightning Rod Act he had carried out the duties assigned to

him and the Act, as revised, has been passed by the Legislature.

Votes of thanks were passed to Willis Chipman and Col. H. J. Lamb for their indefatigable work in connection with legislation in this province, and also to Geo. T. Clark for his conspicuous services to the branch and to the profession generally in vigorously directing the work of the branch during the last year.

The auditors, H. A. Goldman and T. L. Crossley, reported to the committee that the books of the secretary-treasurer had been examined and found to be correct. The nominating committee of which G. A. McCarthy was chairman, acted as scrutineers and reported that the following had been elected to office for the ensuing season: chairman, Wm. Storrie; vice-chairman, E. G. Hewson; secretary-treasurer, F. B. Goedike; committee men, R. C. Muir, N. D. Wilson and W. A. Duff.

The retiring chairman then called the chairman-elect, Mr. Storrie, to take charge of the meeting. In accepting the office Mr. Storrie regretted that by reason of the exigencies of election the services of some valuable members of the executive would unfortunately be lost for the coming year. He advocated that the position of chairman, at least, should be filled by acclamation and pointed out that certain advantages would accrue from the branch electing the executive and the executive electing the officers. F. B. Goedike and W. A. Duff of the new executive expressed their thanks to the membership for the support which they had received.

THE LAW AND ENGINEERING

AN UNUSUALLY clear presentation of the defects of engineering contracts was made by Alfred Bicknell of the legal firm of Bain, Bicknell, MacDonell & Gordon at the meeting of the Toronto Branch of the Engineering Institute of Canada held on March 9. The subject of Mr. Bicknell's address was "Some Legal Aspects of Engineering Problems," a topic that is of considerable interest to engineers, as was evidenced by the unusually good attendance for a meeting held so late in the session.

Mr. Bicknell, in introducing the subject, outlined the character of the work of the lawyer and the nature of law, contrasting statutory law with the common law. Enactments by statute, said the speaker, may recount what has been the law, or may establish new laws or regulations.

He pointed out that the statutory law differs by provinces, thus causing a good deal of confusion in interprovincial relations. Mr. Bicknell deprecated the practice of making numerous and frequent amendments to the statutes without an effort at codification. Where an act was not published with all the amendments incorporated in the text, there is a great chance of confusion and error. Codification is particularly necessary for the law of engineering and building.

The speaker traced the common causes of dispute in building and construction relations, pointing out that the owner is commonly ignorant of what he really wants, what the plans actually provide for, and as to whether the plans and specifications have been adhered to when the work is completed. He must entrust the whole matter to a technical expert, i.e., an architect or engineer who is constituted at one and the same time an impartial arbitrator and an agent of the owner.

Mr. Bicknell described at considerable length the essentials of a binding agreement, stressing the fact that there must be a clear offer and an equally clear acceptance. He cited many cases where a conditional acceptance had created litigation and had resulted in serious loss to one or other of the parties. Wherever new terms are introduced into the proposal there is no definite meeting of the minds, unless both parties definitely agree to them. A detail of interest to contractors mentioned by the speaker was that a tender or offer may be withdrawn any time before acceptance. If acceptance must be made in a definite or prescribed manner, and it not so made, there is no binding contract.

The essentials of contractual relations with corporations including municipal corporations and trading corporations, were then discussed by Mr. Bicknell. He pointed out that the danger attending agreements with municipal corporations requiring the authority of by-laws to undertake certain enterprises. Unless such by-law is passed the person making a contract with the municipality is not able to recover. He cited the particular case of Montreal where unless a definite appropriation has been made for work, or the expenditure has been positively authorized by the governing body of the city, the contractor cannot obtain compensation for his work. Mr. Bicknell mentioned the fact that in order to take action against the Dominion or Provincial governments, it was necessary to first obtain a fiat of the Minister of Justice or the Attorney-General, respectively, and then to proceed by petition of right. While governments are in some respects powerful, said the speaker, they have no authority to modify the terms of a definite contract. He cited the case of the Minister of Public Works of Canada in a former government illegally ordering certain extras to be carried out in the construction of a wharf. As the contract definitely said that extras would be allowed only on the written order of the engineer in charge, the contractor was unable to recover for the extras.

Following the address a vigorous discussion occurred in which many members of the Branch took part. A. T. C. McMaster wished to know how the submission of a cheque with a tender affected the withdrawal of the tender before acceptance. A. A. Robertson asked what should be regarded as a reasonable time for acceptance. T. L. Crossley enquired as to whether an unconfirmed telegram had binding power. J. B. Carswell pointed out some of the weaknesses of common contracts from the point of view of the contractor. He called the attention of the Branch to the standard contract form prepared by the Canadian Association of Building and Construction Industries and urged that action be taken on this form by the Council of the Institute to whom it had been submitted a year ago. J. M. Oxley objected to plans being classed as goods under the law and wished to know what the powers of a municipal commission were in retaining expert assistance by the mere authority of the executive of the commission. E. M. Proctor expressed the view that where the mayor of a municipality causes the employment of an expert without the authority of a by-law he should be liable on the ground of breach of warrant of authority. He wished to know if the motion of a municipal council to which the seal was attached would be regarded as a by-law. He called attention to the fact that in a case where a contractor had built a bridge on the verbal instruction of the council without definite by-law or written resolution he had been able to obtain payment for his work by appealing to the courts. William Storrie asked if it is necessary to wait until a nuisance has actually been created before applying for an injunction to restrain the parties contemplating an objectionable act.

Mr. Bicknell in replying to the various questions asked, stated that the submission of a deposit cheque with a tender did not prejudice the right of the bidder to withdraw his bid before acceptance. A reasonable time for acceptance would have to be established with all the circumstances of the case in mind. A telegram really does not require confirmation in order to be legally binding, said the speaker, although confirmation is most desirable to prevent possible errors in transmission. The actual status of the architect, according to the speaker is outlined in the contract, where his powers are definitely defined. He is in some respects an agent and in others an impartial arbitrator between two parties. The authority of a municipal commission to enter into contract should be based upon its status as a trading corporation, said Mr. Bicknell. He was of the opinion that the motion of a municipality with a seal attached was in effect a by-law. Replying to Mr. Storrie, the speaker stated that it was not necessary to await until a real nuisance had been created but if it could

be established that a contemplated act would undoubtedly create the nuisance, the injunction could be obtained beforehand.

Other members contributing to the discussion were R. J. Fuller, H. A. Goldman and C. R. Young.

RAILWAY DEPARTMENT FORMED BY WISCONSIN HIGHWAY COMMISSION

THROUGH the formation of a Railway Department as an active branch of the Wisconsin State Highway Commission, definite recognition has been given to the necessity of careful planning in the relocation of highways and expert consideration of the question of eliminating grade crossings.

M. W. Torkelson, former bridge engineer for the Wisconsin commission, has been placed at the head of the new Railway Department. His work will be chiefly connected with relocation of highways and elimination of grade crossings. The Wisconsin authorities are firmly convinced that many dangerous crossings can be eliminated by proper steps before expensive improvements are carried out, and that by careful relocation many of these crossings can be abolished altogether.

Highway officials, as shown by the Wisconsin innovation, are realizing more and more that the duties of government departments include not only the construction of good, durable roads, but precautions for the safety of the motoring public, such as separated grades and properly located routes.

Notice has been given that a charter is being sought for the erection of a bridge over the Niagara River to connect Fort Erie and Buffalo.

According to chief engineer A. Grant, work on the various sections of the Welland Ship Canal, under contract will be under way by the end of March. Already, contractors are increasing their force of men no less than 1,000 being at work at sections 3 and 4. Porter Brothers have doubled their staff at sections 1 and 2, over their January force. With the opening of work upon a larger scale, considerable relief is expected in the unemployment situation throughout the Peninsula and is already being felt in some measure.

Engineers of Ottawa participated in an extremely enjoyable function on March 16, at the Chateau Laurier, where luncheon was held under the auspices of the local branch of the Engineering Institute of Canada. The chairman of the branch, K. M. Cameron, presided, and there were ten speakers, all past-chairmen of the Ottawa branch, who were each given three minutes to tell engineering stories. A prize was the reward offered by the chairman for the speaker adjudged to have told the best yarn. Of the past-chairmen of the branch since the year 1909 inclusive, only three found it impossible to attend, W. J. Stewart, who was chairman in 1910, S. J. Chapleau in 1912, and G. A. Mountain in 1914.

Medals of the Engineering Institute of Canada have been presented to the following members. P. Ackerman of the Shawinigan Power Co. the Czowski gold medal for his paper on the relay protective features of the Toronto transmission and distribution system. The Plummer medal went to Dr. Alfred Stansfield, professor of metallurgy at McGill. It is presented and endowed by J. H. Plummer of the Dominion Iron and Steel Co. for the best paper on metallurgical subjects. For the first time the Leonard Medal, prepared according to designs made by Walter J. Francis and F. J. Brown and approved by the Institute as well as the donor, a virgin medal in honor of the event, will be presented to Lt.-Col. W. R. Leonard, of St. Catharines, Ont. The medal is made from pure gold from the Coniagas Mine.

Engineer's Library

MECHANICAL TESTING

Reviewed by

Peter Gillespie,

Professor of Civil Engineering, University of Toronto.

MECHANICAL TESTING—A Treatise in Two Volumes—By R. G. Batson and J. H. Hyde, assistants in the Engineering Department of the National Physical Laboratory, Teddington, England. Vol. I. London: Chapman & Hall; The D. U. Series. Cloth; 5 by 8½ in.; pp. 413; profusely illustrated; 21s.

In a review of an American book entitled "Addresses to Engineering Students" published a decade ago, the present writer remarked that in the compilation of the volume in question, the editors had not seen fit to go beyond the boundaries of the United States for their material and that from the ripe scholarship and varied professional attainments of British engineers it contained not a single message. The provincialism there complained of is happily not observable in the volume before us. The publications of all progressive nations have been freely and diligently consulted and as generously acknowledged and while the text displays some features peculiarly English, much of its excellence is due to its cosmopolitan character.

The first three chapters are given over to a consideration of the fundamentals of theoretical mechanics, the theory of stress and strain and the elastic behavior of materials under stress. We cannot help feeling that something would have been gained had a uniform method of orienting stress-strain and load-deformation curves been followed instead of the two methods indiscriminately used.

In that section devoted to testing machines and accessories, the mechanical principles governing the design of testing machines of the single lever, multiple lever pendulum, and Emery types, etc., are explained. By numerous half tone engravings and line drawings most of the types are illustrated and their methods of operation made plain. In order to secure accuracy, obviously the first desideratum in a testing machine, ease of calibration and sensitiveness are declared to be essential. Other requirements are given as accessibility for easy operation and simplicity and convenience in the method of gripping the specimens. With these assertions, all users of testing machines will be in agreement.

Chapter eleven is given over to a description of precision instruments whereby deformation in stressed material may be accurately measured. These include extensometers, compressometers, torqueometers and deflectometers. The devices primarily employed are classified as follows: (1) the micrometer screw, (2) the indicating dial, (3) the microscope, (4) the multiplying lever, and (5) the optical magnifier.

The limit of precision of the mirror apparatus, the last mentioned and of which the Bauschinger and Martens extensometers are types, is given as 4-millionths of an inch which is probably not inaccurate. Most of the illustrative drawings are diagrammatic only—all non-essential parts having been omitted—and are readily understood.

Other matters treated in the text in a usually comprehensive way are Commercial Testing, Cast Iron, Effect of Shape of Specimen and Time of Loading, Autographic Apparatus, Repeated Stresses, Fatigue in Materials, Hardness and Abrasion, Temperature Effects, Timber, Stone, Brick and Concrete, Road Materials, Limes and Cements, etc.

An excellent feature of the text is the inclusion at the end of each chapter of a partial bibliography covering the topic treated therein. While the text does not pioneer any new fields, it brings together in a lucid and usable way the present day knowledge of the art of commercial and scientific testing. The presswork and paper are good and alto-

gether it is a volume that should appeal, as the preface implies was intended, to the engineer, the manufacturer and the student.

Volume II is not yet off the press.

SEWAGE PURIFICATION

Reviewed by

Hector S. Philips

Assistant City Engineer, Hamilton, Ont.

MINISTRY OF HEALTH REQUIREMENTS AS TO SEWAGE PURIFICATION—With extracts from the reports of the Royal Commission, and other engineering data. By S. H. Adams; 39 pp., demy 8 vo., cloth. Published by St. Bride's Press Ltd., 24 Bride Lane, Fleet St., E.C. 4, London, Eng. Price, 6s. (\$1.50) net, post-free, 6s. 4d.; limp leather binding, 1s. 6d. extra.

This book, now in its fourth edition, is published under the auspices of the Ministry of Health (England) and much has been added to former editions in the way of selected passages from the well-known "Reports of the Royal Commission on the Treatment of Domestic Sewage and Trade Waste Liquors."

Mr. Adams has admirably presented the Requirements of the Ministry of Health as to sewage purification, summarized in the form of tables and charts, with explanatory notes, together with a compilation of standards of purity of effluent as governed by the available dilution required by the various English rivers or drainage boards. Charts are reproduced from the Fifth Report of the Royal Commission which show the results which may be expected of strong, medium or weak sewages by certain standard types of treatment.

Mr. Adams has also included a brief explanation of various processes of sewage treatment from chemical purification to activation and bio-aeration.

Other principal contents are a statistic chart prepared by Mr. Adams, showing tanks, filter capacities, etc., and tables devoted to amounts of removal of suspended matters in tanks after different treatments. Quantity of tank liquors which may be treated in percolating filters and contact beds, summary of the "Requirements" as to tanks and filters, amounts of air required for the activated sludge system, volumes of sludge produced by different processes of treatment, amount of treatment necessary to effect purification of different classes of trade waste liquors, and so on.

The remainder of the book is taken up by miscellaneous tables of sewerage and other useful engineering data together with the author's notes on velocity of sewage flows, water consumption samples and analysis, etc. Examples of sewer-flushing diagrams made by the author after a series of tests extending over a number of years are also published.

It is regrettable that tables only of flow in sewers are given, as diagrams on logarithmic paper have a much wider application. More information regarding sewage-disposal matters based upon Mr. Adams' own wide experience, would be welcome in future editions.

The general style of the book is concise and while it is of especial interest to engineers engaged in preparing sewage-purification schemes in Britain, it should be invaluable to all sewerage engineers as a book of ready reference.

STORING AND SEASONING CROSS TIES—Bulletin No. 20, issued by the Century Wood Preservation Co., Pittsburgh, Pa.; 16 pages, 8½ x 11 in., printed on coated paper; well illustrated. This bulletin discusses air seasoning and the factors which influence it, seasoning by steam, possible deterioration of ties while seasoning, the handling and storage of cross-ties, and methods of piling ties.

MANUFACTURE OF PORTLAND CEMENT by Arthur C. Davis. Published by John Falconer, Dublin, Ireland. Third edition; 416 pp.; 100 illustrations; 5½ by 8½ ins.; leather; \$6.50.

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STRESS DETERMINATION BY PAPER MODELS

LABORIOUS determination of stresses in statically-indeterminate frames and structures has suggested to many designers the expediency of stress determination by measuring the deformation of models. From time to time instances of such procedure have occurred, but unusual success has been achieved in this regard by Professor Geo. E. Beggs, of Princeton University, who recently communicated the results of his researches to the American Concrete Institute at its annual meeting.

Suggested originally by the determination of the reactions of a continuous bridge truss of three spans by observing the deformations of a wooden strip, Professor Beggs extended these investigations to a variety of statically-indeterminate frames. These at first were made of celluloid, but later of cardboard to a reduced scale. A known load was then applied at a selected point and the deformation produced thereby at that point was observed by means of a microscope. At any other point where the stress condition was to be determined, another microscope was placed and the deformation accompanying the loading was found. Then by applying Maxwell's principle of reciprocal deflections, he was able to determine the stress at the second point. The models studied were of arch ribs, portal frames, circular rings, transverse bents, a series of arches, culverts, and related structures. The results of this mechanical stress determination were checked up carefully by the correct theory and the conformity of the results was surprisingly close. Indeed, in some cases, Professor Beggs is of the opinion that the stress determination by model is more accurate than by theory.

If stresses made thus be found in complicated structures by the construction and observation of small size models with sufficient accuracy for all practical purposes, it is to be expected that a much more extensive use will be made of this method than has heretofore been the case. The extraordinarily tedious calculations required in solving some complicated frames often lead to the practical man making a guess at the stresses rather than figure them out accurately. It may thus happen that through the incentive given by the researches of Professor Beggs, a closer proportioning of statically-indeterminate structures may arise, and at the same time the economic properties of restrained and continuous frames may be taken advantage of rather than avoided on the ground of difficulties in design.

THE TROLLEY BUS ARRIVES

CONSIDERABLE promise as a transportation agency is offered by the trackless trolley or so-called trolley bus. As a result of experimental work undertaken by the General Electric Co., trolley buses have been installed at Norfolk, Va., Richmond, Va., and Staten Island, N.Y. and have now been operating for some time. Based on a movement of over 100,000 bus-miles, it is said that the operating cost is approximately 18 cents per bus-mile. If this be a reliable figure on which to base comparisons it is evident that both the electric car and the motor bus will have to meet keen competition from this new vehicle. Certain investigations made by the Commissioners of the Department of Public Utilities of the State of Massachusetts indicate that allowing for taxes and interest on investment at 8%, the cost per bus-mile averages about 24 cents, per electric car-mile about 48 cents, per car-mile for one man safety car about 25 cents, and per trolley bus-mile about 21 cents. Apparently, therefore, the trolley bus is able to compete advantageously with these other forms of transport.

The basis of economy in trolley bus installations is of course the fact that no expenditure for track or roadway construction is necessary and that the power cost is less than for motor bus. Overhead construction is but little more expensive than that required for ordinary electric cars and the type of vehicle is much cheaper than the electric car.

Recently, four trolley buses have been purchased by the City of Toronto and are to be tried out in an experimental way on Mount Pleasant Road. The results obtained will have an important bearing on the future of this form of transport in Canada. It would be too soon, however, to adopt any definite transportation policy with respect to the trolley bus until it has been tried out under all probable weather and operating conditions.

WATER POWER DEVELOPMENT IN CANADA AND THE UNITED STATES

IN A popular magazine published in the United States, reference was recently made to the fact that according to the United States Geological Survey, 40% of the developed water power of the world is in the United States, although that country possesses only 6% of the total potential water power. Reference is made with evident satisfaction also to the fact that the water wheels of the United States have a present capacity of 9,243,000 h.p.

While it is not desired to minimize the achievements of the republic to the south in the matter of water power development, it is of interest to note that the water power development per capita in Canada is 201% more than it is per capita in the United States. At the end of 1920 the installed horse-power per thousand of population in Canada was 280, whereas per thousand of population in the United States it was only 93. It is no doubt true that the lack of fuel in this country has been responsible for the comparatively intense development of water power, but this fact renders the achievement no less remarkable.

PERSONALS

BENJAMIN MICHAUD, Deputy Minister of Highways for Quebec for nearly 25 years, has been given six months' leave of absence on account of ill-health.

PERCY J. JENNINGS, acting assistant commissioner of irrigation, has been elected chairman of the Calgary branch of the Engineering Institute of Canada.

RUFUS STENTON, of Port Lampton, Ont., has been appointed a county road commissioner on the highway between the fifth and ninth concessions, Sombra Township.

HARRISON P. EDDY, consulting sanitary engineer of Boston, Mass., was in Hamilton, Ont., last week looking over the sewer system and consulting with the local authorities.

A. B. SILCOX has been appointed director of the Citizens Municipal Research League of Calgary. Mr. Silcox, who graduated from Toronto University in 1906, is at present head of the Engineering branch of the Toronto Municipal Research Bureau.

OBITUARIES

WILLIAM CANNELL, president of the Cannell-Spencer Construction Co., Edmonton, Alta., died on March 12 after a long illness. The deceased was born in Bruce County, Ont., in 1866 and moved to Edmonton in 1903, where he founded one of the first contracting companies organized in that city.

THOMAS S. BROOKES, a former well-known contractor of Vancouver, B.C. and Kingston, Ont., died recently at the age of 79 at Vancouver. The deceased was born in England and came to Canada 48 years ago, settling in Kingston, where he lived 24 years. In 1900 he moved to Vancouver and continued to carry on business as a building contractor.

MANUFACTURERS WOULD AID BUREAU OF RESEARCH

IN DEALING with the establishment of a National Bureau for Industrial Research, the Canadian Manufacturers' Association made representations to the Dominion Government that a measure similar to the one defeated in the Senate at the last session should be enacted.

From a national standpoint, Governmental expenditure with the object of improving the quality or increasing the quantity of any class of production is at all times advisable. This has been recognized by Governments in the past in connection with agriculture, technical education and reforestation.

From an industrial standpoint, the method by which the greatest assistance can be rendered by the Government to manufacturers is the establishment of an Industrial Research Bureau, with facilities for conducting experiments which must of necessity be carried on for the development of manufacturing.

Probably no single factor was more conducive to the rapid expansion of Germany industrially than was the assistance rendered by the German Government in this manner. In recent years an attempt has been made along such lines by the Honorary Advisory Council for Scientific and Industrial Research, but as the services of those connected with the Council were given voluntarily, and as no facilities were placed at their disposal for experiments, their accomplishments, while valuable, were necessarily limited.

"The Canadian Manufacturers' Association realizes that at the present time new expenditures should be incurred only for pressing necessities or where they will result in benefits fully justifying the outlay. It believes that the good results which will accrue from an appropriation necessary to provide accommodation, equipment and staff for a Bureau of Standards and Research at Ottawa would in a short time increase the national wealth out of all proportion to the expenditure entailed, and we consequently request the Government to give such proposed expenditure their earnest consideration."

Letter to the Editor

LIBRARIES FOR RESEARCH WORKERS

Sir—I note with interest the letter from A. S. L. Barnes on page 294 of your issue of March 7, and I should like to do what I can to encourage Toronto to have a central catalog of the various organizations mentioned, and as many others as would be interested. We have been groping around for something of this sort in Boston for a long time and lately have been talking about a "community catalog," which would contain references not necessarily to all books owned by the co-operating libraries, but to books that it would hardly pay more than one or two to own, and these on the principle that "If you will buy this book, I will buy that." The same principle would apply to out-of-the-way periodicals.

The Boston Public Library, the Harvard College Library, and the Library of the Institute of Technology have been considering the "co-operative catalog", and it is likely that out of the various plans afoot something will happen here before long. In the meantime, some of us have been at work on what we call the "Coordinator," a series of loose sheets indicating where to find information in the vicinity, particularly on subjects of wide interest.

Thus far, we have sheets on seven or eight subjects, including, Tel-U-Where Company of America, Foster Service, Availability of Lantern Slides, Vocational Information, and two or three others. Also, I have been getting about twenty-five students in a graduate class at Harvard to work up subjects as a part of their class practice, and with a view to co-ordinating academic and business life. These subjects are all presumably of interest to such organizations as Stone & Webster, Inc., and various other engineering and commercial concerns.

G. W. LEE,

Librarian, Stone & Webster, Inc.

Boston, Mass., March 13, 1922.

GOOD ROADS ASSOCIATION CONVENTION

AT TENTATIVE program is being prepared by Secretary George A. McNarnee of the Canadian Good Roads Association at the head office in the New Birks Building, Montreal, for the ninth annual convention to be held at the Empress Hotel, Victoria, B.C., on June 13-16, inclusive. The program will include addresses by distinguished highway authorities of Canada and the United States, and will be even more comprehensive than at any previous convention, as an extra day will be devoted to business sessions, making four days instead of three utilized in past years. All sessions will be conducted on daylight-saving time if it is in force in Victoria. For the fifth day, Saturday, a number of sightseeing trips will be arranged which should prove both educative and entertaining.

The convention is being held in direct co-operation with the Good Roads League of British Columbia and the Good Roads Association of the Western Provinces. The official recognition extended to the Canadian association is indicated by the fact that assurances have been received of the presence as delegates of Dominion Government highway officials, Provincial Ministers with their deputy Ministers and chief engineers, highway commissioners and the Mayors, councillors and engineers of many municipalities. There will also be representatives of contracting firms, suppliers of paving materials and machinery and the automotive interests.

An illustrated lecture on the "Chippawa Canal Development," by R. T. Jeffrey, of the Ontario Hydro-Electric Commission engineering staff, was given before the Rotary Club in the Chamber of Commerce, Brantford, on March 16.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Regina, Sask., erection of Chemistry Building	Mar. 31	Mar. 7
Lethbridge, Alta., masonry construction Morton, Man., gravelling of several St. Catharines, Ont., road construction and material	Mar. 30	Mar. 14
Chippawa, Ont., construction of concrete intake structure and ship channel in Niagara River	Apr. 1	Mar. 14
Halifax, N.S., highway construction, Yarmouth-Shebbourne County line to Woods Harbor	Apr. 10	Mar. 14
Ontario, Province of, widening and deepening the channel of the Welland River and a portion of the Queenston-Chippawa power canal..	Mar. 30	Mar. 14
	Apr. 10	Mar. 14

BRIDGES, ROADS AND STREETS

Bridgeburg, Ont.—The question of a viaduct over Central Ave., to connect the Amigari section of Bridgeburg with the remainder of the town, is to be taken up with the Dominion Railway Board immediately. Town Clerk, H. G. Patriarche.

Calgary, Alta.—The city commissioners recently met P. L. Naismith, manager of the Natural Resources Department of the C.P.R., and discussed with him the possibility of the C.P.R. becoming a party in the construction of a new bridge over the irrigation canal at Seventeenth Ave. East and the city limits. It is understood that the C.P.R. has intimated their willingness to come into the scheme.

Chatham, Ont.—Contract for the construction of 2½ miles of pavement to Richmond St. has been let to Campbell & Lattimore, Toronto.

Chatham, Ont.—Chatham Suburban Area Commission is planning an extensive program for this year. Over two miles of road on the Chatham-Dover town line will be paved, and other roads close to the city will be improved.

Chatham, Ont.—Chatham Suburban Area Commission is planning an extensive program for this year. Over two miles of road on the Chatham-Dover town line will be paved, and other roads close to the city will be improved.

Ford City, Ont.—Town Council considering purchase of digging and paving machine. Clerk, J. F. Foster.

Guelph, Ont.—Public Works Committee will recommend to City Council that a pavement be laid on Kathleen St., Glasgow St., Waterloo Ave., Dublin St., Lyon Ave. and the London Road. City Engineer, F. McArthur.

Hamilton, Ont.—City Engineer E. R. Gray will prepare an estimate on cost of widening parts of Catharine St.

Hamilton, Ont.—The asphaltting of Gage Ave. northerly to the plant of the National Slag Products Co. was decided on by City Council. Also construction of a concrete sidewalk on Burlington St.

Hamilton, Ont.—Authorization for the raising of Ferrie Street bridge and the G.T.R. tracks to accommodate the

Wellington St. storm overflow sewer, was received by City Council from the Dominion Board of Railway Commissioners.

Harrow, Ont.—Township Council of Colchester South is securing a loan of \$10,000 from the Department of Highways for road improvements. Clerk, J. H. Madill, Harrow.

Kitchener, Ont.—City Council decided to pave Weber St., between the G.T.R. and Breithaupt St. City Engineer, S. Shupe.

London, Ont.—Middlesex County Engineer Charles Talbot is preparing plans for county road improvements this year that will approximate \$200,000. The bulk of this amount will be for maintenance. About \$25,000 will be expended on new bridges and culverts.

North Toronto, Ont.—North Toronto Ratepayers' Association made an application to the council for co-operation in the movement to have a subway at the G.T.R. crossing on Eighteenth St. Council approved and will support the object.

Ontario, Province of.—Hon. F. C. Biggs, Minister of Public Works and Highways, introduced into the Legislature an act to provide for future construction and maintenance operations on the Toronto-Hamilton highway. It contains also a slight amendment to take care of the building of the last bridge on the highway.

Ottawa, Ont.—Suburban Road Commission decided to call tenders for a mile of sheet asphalt on the Richmond road and 2½ miles of sheet asphalt on the Metcalfe road. Also for 60,000 gallons of bituminous material, for 1,000 barrels of cement and a quantity of pipe. Chairman, John Bingham.

Peterboro, Ont.—Board of Works decided to have a concrete pavement laid on George St. south, from the C.P.R. to Romaine St. Tenders will be called. The Board also authorized the purchase of \$50,000 gallons of road oil. City Engineer, R. H. Parsons.

Sandwich, Ont.—The Canadian end of the Detroit-Windsor suspension bridge will be in Sandwich, and construction will probably begin in May, it was recently announced at the offices of the American Transit Co., in Detroit.

Sandwich, Ont.—Essex County Council approved an expenditure of \$607,000 for good roads and the maintenance of old roads this year. Road Superintendent, W. K. Kinster, Sandwich.

Sherbrooke, Que.—The following by-laws will be submitted to the ratepayers: To provide \$175,000 for the construction of sidewalks; viaduct, \$25,000; reconstruction of Dufferin Ave. bridge in steel and concrete, \$55,000; leveling of King St. west, \$20,000.

Stratford, Ont.—It is likely that Erie, Britannia and Hamilton Streets, and part of Perth St. will be paved this summer. City Engineer, A. B. Manson.

Toronto, Ont.—Extension and grading of Patterson Ave. to Sunnyside Ave. passed City Council.

Toronto, Ont.—The proposed Riverdale Ave. extension through the Harris estate to Pape Ave., was referred back to the works committee by the City Council.

Toronto, Ont.—City Council intends to construct concrete sidewalk on Teranulay St. west side, from St. Joseph St. to St. Mary St., at a cost of \$3,300; also asphalt pavement on same street, from College St. to Davenport Road, \$240,896.

Toronto, Ont.—The City Council decided to reconsider the Illoor St. widening project, and referred it to the Works Committee, so that the members of that body may, should

they think it advisable, forward a new recommendation that the work be proceeded with.

Toronto, Ont.—It is stated that Works Commissioner Harris has put a proposition before the steam railway companies in connection with the Bloor St. "gap" problem, upon the following basis: (1) A subway to be built under the northern division tracks; (2) a bridge to be built over the middle division and C.P.R. tracks.

Toronto, Ont.—Tenders for concrete pavements were received on March 6 by the Ontario Department of Public Highways from the following firms: Campbell & Lattimore, Toronto; Lumsden Engineering & Transport Co., Toronto; G. G. Chisholm, London; Archibald Construction Co., 122 Delaware Ave., Toronto; Cadwell Sand & Gravel Co., Windsor; Kingston Construction Co., Kingston; Frid Construction Co., Hamilton; W. J. Boss, London; McNamara Bros. & Thornton, Sault Ste. Marie; Sheehy & Son, Peterboro; Chick Construction Co., Windsor; Johnson Bros. Co., Ltd., Brantford; Oakwood Construction Co., Ltd., Windsor. No official announcement has yet been made regarding awards.

Toronto, Ont.—Tenders for asphaltic concrete pavements were received on March 6 by the Ontario Department of Public Highways from the following firms: Roger Miller & Sons, Toronto; Johnson Bros. Co., Ltd., Brantford; Brennan Paving Co., Arnprior; Provincial Contracting Co. (Kilmer & Barber), Toronto; Godson Contracting Co., Ltd., Toronto; Warren Paving Co., Toronto; Standard Paving Co., Ottawa; McQuigge & Russel, Excelsior Life Building, Toronto; Constructing & Paving Co., Toronto; Bartram Construction Co., Toronto; Merlo, Merlo & Ray, Windsor. It is unofficially rumored that contract has been awarded to Rodger Miller & Sons for the Ancaster road, to Johnson Bros. for the Winona road, and to Brennan Paving Co. for the Galt road.

Windsor, Ont.—Ouellette Ave., Wyandotte St., Mercer St., Montmorency St. and Howard Ave. will be surfaced with sheet asphalt this year. City Engineer, M. E. Brian.

York Tp., Ont.—The Township Council plans to widen Scarlett Road, Dawes Road, Dundas St., Vaughan Road and Weston Road.

WATER, SEWAGE AND REFUSE

Guelph, Ont.—Public Works Committee will recommend to City Council that a storm sewer be laid on Derry St. City Engineer, F. McArthur.

Hamilton, Ont.—Board of Health recommended sewers on Simcoe St., from Mary St. eastward, and on an alley between Mary and Ferguson Ave., near Simcoe St.

Kitchener, Ont.—City Council decided to construct a sewer on Pandora Ave., between Weber and Samuel Streets. City Engineer, S. Shupe.

Mimico, Ont.—Water mains are to be laid this spring on Dean St., from Cunard to Dwight; on George St., from Mimico Ave. to Edythe Ave.; from Lake Shore Road to Central Ave., on Hillside to Melrose; on Milton, from Melrose to Algoma, and on Algoma, from Wesley to Milton St. Clerk, J. A. Telfer.

Niagara Falls, Ont.—Water Commission decided to have mains laid on Elm St., Ross, Spring, Summe and Orchard Streets. Commission will call for tenders for proposed booster pumphouse and dwelling.

Niagara Falls, Ont.—Bell & Bell were awarded contract for trenching and back-filling in connection with the city's water works; H. W. Bickle & Co., Main St., were awarded contract for galvanized pipe and fittings; and Gartschore-Thompson Pipe & Foundry Co., Ltd., Hamilton, were awarded contract for cast iron pipe.

Ottawa, Ont.—City Council intends to construct 15-in. tile sewer in Ralph St., from Broadway Ave. to the lane between Woodlawn Ave. and Center St.; in the said lane from Ralph St. to Monk St.; and in Monk St., from the said lane to Center St. Also a 12-in. tile pipe sewer in Ralph St., from the said lane to Center St. Estimated total cost, \$10,447. City Clerk, N. H. H. Lett.

Sherbrooke, Que.—By-law for providing for the raising of \$115,000 for the construction of sewers will be submitted to the ratepayers.

Woodstock, Ont.—Local Board of Health will request City Council to submit a by-law at next municipal election to provide \$38,500 for an incinerator.

LIGHT, HEAT AND POWER

Kitchener, Ont.—City Council decided to proceed with the construction of a 6-in. gas main on King St. east, between Cedar Grove and Sheldon.

London, Ont.—City will apply to the Provincial Legislature for authority to raise \$141,000 for the construction of a dam in the River Thames at Springbank Park.

St. Catharines, Ont.—Fire damaged the plant of the Packard Electric Co., Ltd., to the extent of \$20,000. Six large transformers for the Hydro Commission, which were ready for shipment, were damaged.

Windsor, Ont.—The development of hydro-electric power at Avon Falls, near here, is projected by the Avon Power Co.

York Tp., Ont.—Township Council approved of Hydro lights for Willard Ave., Frater Ave., and Westmount Drive.

RAILWAYS

Fraserville, Ont.—J. D. McMillan, superintendent of the G.T.R., announced that work on the new station will commence shortly.

Hamilton, Ont.—City Council approved construction of a railway siding on the east side of Ferguson Ave., between Kelly and Wilson Streets.

Kitchener, Ont.—City Council approved of the extension of the Waterloo and Wellington Railway through to Guelph.

Toronto, Ont.—Transportation Commission desires to lay a double-track on Elizabeth St., from Dundas to Louisa, and single-tracks on Louisa, from Elizabeth to Teraulay; on Albert St., from Teraulay to Elizabeth, and on Elizabeth, from Albert to Louisa St. Estimated cost of widening Elizabeth St., Albert and Louisa Street roadways, with 10-ft. sidewalks on the two former streets and a 6-ft. sidewalk on the north side of Louisa St., is \$75,000. Commission also desires to instal special work on Christie St. near Dupont St., and at the corner of Lansdowne and St. Clair Avenues. Estimated cost of pavement in both cases is \$1,148.

Windsor, Ont.—The management of the Essex division of the Hydro-Electric Railways contemplates laying new steel on Sandwich St., between Ouellette Ave., and Ferry St., this season. Tracks outside the towns of Tecumseh and Amherstburg will be rebalasted, and a booster station will be constructed at Amherstburg, if the entire program is carried out.

FACTORIES AND LARGE BUILDINGS

Annapolis Royal, N.S.—A new Town Hall, Court House and possibly a new hotel will be constructed this year.

Brantford, Ont.—The members of Shenstone Memorial Baptist Church plan erection of new church. Pastor, N. R. McCleod.

Bridgetown, N.S.—The members of Bridgetown Baptist Church decided to erect a Church School building. Pastor, Rev. Clyde W. Robbins.

Brockville, Ont.—The Bank of Toronto is about to commence the erection of new premises.

Bronte, Ont.—The erection of a school is projected.

Calgary, Alta.—Separate School Board plans erection of a four-room addition to St. Ann's school, at a cost of \$20,000.

Calgary, Alta.—Tenders will shortly be called for alterations to the stores building at the General Hospital. City Architect, Mr. Richards.

Chatham, Ont.—Board of Education is considering erection of Technical School.

East Toronto, Ont.—East Toronto Branch, G.W.V.A., decided to erect a clubhouse at a cost of \$25,000.

East Toronto, Ont.—Members of Calvary Baptist church have launched a campaign to raise \$25,000 for building purposes.

Edmonton, Alta.—Plans have been prepared for the new Eastwood school. Estimated cost, \$165,000.

Edmonton, Alta.—Empire Loan & Trust Co., of Winnipeg, will erect a garage at the corner of 102nd Ave. and 100th St., at a cost of \$25,000. Architects, Magoon & MacDonald. It is reported that a \$10,000 building is to be built on the west side of the new city telephone exchange for an "Orange Crush" factory.

Fort William, Ont.—A new building will be erected at the Industrial Farm this year at a cost of \$40,000.

Halifax, N.S.—Contract awarded to W. F. Bedwin & Co. for alterations to the Bloomfield school, at \$15,923.

Hamilton, Ont.—The local Hydro Commission plans to erect its proposed four-storey building on Catharine St. Chairman, Guy Long.

Hamilton, Ont.—Permit issued to Separate School Board for brick school building on Whitefield and Gage Avenues, costing \$25,000.

Hamilton, Ont.—W. T. Tomes, real estate agent, plans the erection of a large apartment house at the corner of King St. and Proctor Boulevard. Estimated cost, \$80,000.

Lacombe, Alta.—Work will commence this spring on the erection of a business block on the corner of Barnett Ave. and Railway St.

London, Ont.—Work on the erection of the Lloyd George Hotel will be started within a week.

Mimico, Ont.—Mimico and Long Branch Baptist Churches, having raised the necessary funds, will commence building operations on the new buildings shortly.

Mount Elgin, Ont.—Ratepayers of School Section No. 5 plan the erection of a continuation school costing \$15,000.

North Toronto, Ont.—A movement is on foot to have a railway passenger station erected at Eighteenth St.

Ontario, Province of.—Plans are being prepared by a London architect for the erection of the following schools: Six-room school at Hensall, four-room school at Melbourne, eight-room school at Springfield, two-room school at Mt. Elgin and a large school in connection with the Centennial Methodist Church in Sarnia.

Ottawa, Ont.—The Ottawa Tennis & Lawn Bowling Club plan the erection of a new clubhouse. Address Col. W. S. Conger.

Ottawa, Ont.—Contract for construction of cooling plant for Swift Canadian Packing Co., at the southeast corner of Bresser and Mosgrove Streets, has been let to Joseph Robert, 34 Laurier Ave. east. Approximate cost, \$10,000.

Pembroke, Ont.—Plans for a separate school for the West Ward have been completed by Architect Millson, of Ottawa.

Port Arthur, Ont.—A. G. Pounsford, manager, Port Arthur division Provincial Paper Mills, Ltd., announced the actual commencement of work on the construction of a paper mill extension to the company's present plant, at an estimated cost of \$1,500,000.

Port Credit, Ont.—School Board plans High School extension.

Port Credit, Ont.—Two rooms will be added this year to the continuation school.

Port Credit, Ont.—Four rooms will be added to Forest Avenue School this summer.

Port Credit, Ont.—Erection of new Anglican and Presbyterian churches is being discussed, and it is probable that steps will be taken this year to provide for the buildings.

Quebec, Que.—A movement is on foot among shipping men to have a second storey added to sheds Nos. 18, 25 and 26. Address W. G. Power, chairman, Quebec Harbor Commission.

Rocky Mountain House, Alta.—By-law passed authorizing raising of \$13,000 for purchase of site and erection of school.

St. John, N.B.—Contract for erection of recreation building on grounds of Lancaster Military Hospital has been awarded to H. O. Clark, at \$6,600.

St. John, N.B.—Erection of a Protestant Orphans' Home, costing between \$200,000 and \$250,000, is projected by the directors of the St. John Protestant Orphans' Home.

St. Stephen, N.B.—The Bijou Theatre, owned by J. W. Smith, proprietor of the Queen's Hotel, was destroyed by fire. Loss, \$15,000.

St. Thomas, Ont.—Alma College Board plan extensions and improvements to the college building, estimated to cost \$100,000.

Sarnia, Ont.—Under the direction of leading Canadian and United States steel men, a new industry is to be launched here to be known as the Dominion Alloy Steel Corporation. Construction of a \$3,000,000 plant capable of turning out 50,000 tons annually of alloy and high carbon steels will be commenced in a few weeks. The complete personnel of the board of directors has not yet been announced, but it is understood that it will include Harry R. Jones, till recently president of the United Alloy Steel Corporation, of Canton, Ohio; C. H. Wills, of Detroit, formerly chief engineer of the Ford Motor Co.; J. J. Mahon, formerly chief engineer of the Crucible Steel Co.; and Geo. A. Simpson, of Hamilton, sales manager of the Steel Company of Canada.

Smith's Falls, Ont.—Fire destroyed a large storage shed on the C.P.R. premises. It will cost \$30,000 to replace the building.

Stonewall, Man.—Rockwood Agricultural Society let contract to build a hall to Walker Bros.

Stratford, Ont.—The following buildings will be erected this year: Four-room addition to Hamlet School, new four-room public school on Downie St. and a \$75,000 mausoleum at the cemetery.

Thorold, Ont.—Methodist Church members have started a campaign to raise \$20,000 for church improvements.

Toronto, Ont.—City Council passed a recommendation that \$100,000 be raised for the erection of a nurses' home.

Toronto, Ont.—City Council sanctioned the purchase of a school site on Roxton Road by the Separate School Board of a 10-room school.

Toronto, Ont.—Jones Bros.' factory, Richmond and Sheppard Streets, is being demolished to make way for an eight-storey modern office building.

Toronto, Ont.—Members of Davisville Baptist Church have launched a campaign to raise \$20,000 for a new Sunday School building. Pastor, Rev. A. P. Wilson.

Toronto, Ont.—Ratepayers of S. S. No. 34, Fairbank, have authorized trustees to issue debentures amounting to \$13,000 for erection of two portable school rooms.

Toronto, Ont.—Confederation of Jewish Philanthropies plan erection of an orphanage on the southwest corner of Homewood Ave. and Wellesley Crescent. Estimated cost, \$50,000.

Toronto, Ont.—By-law will be introduced at next meeting of City Council providing for the raising of \$109,000 for the erection and equipment of a Technical school on Greenwood Ave.

Toronto, Ont.—Windermere Avenue Methodists, Runnymede district, plan the erection of a new church at Ostend and Windermere Avenues. Runnymede Presbyterian Church may also be replaced by a new building to be erected at Willard Ave. and Annette St., at a cost of \$50,000 or \$60,000.

Toronto, Ont.—Erection of four buildings at a cost of \$1,500,000 is contained in a request made by the Toronto University to the Provincial Government. This program includes a new Forestry and Botany building, an Administration building, additions to the heating plant and a Women's building.

Wetland, Ont.—St. Thomas Packing Co., of St. Thomas, will erect cold storage plant here at a cost of \$50,000.

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Developments in Photographic Surveying

Camera Can be Used to Best Advantage in High Mountain Ranges — Description of Apparatus Used — How Photographs are Taken and Plotted — More Work in Office Than in Field

BY M. P. BRIDGLAND

WHEN preparing this article, it was the object of the writer to give a short account of the conditions under which photographic surveys are usually made and a brief description of the field and office work, without any attempt to deal with the subject from a theoretical standpoint. English literature dealing with this class of survey is scarce and in the majority of recognized text books, if mentioned at all, the chapter devoted to the topic does little more than acknowledge the existence of the photographic system or at best offers a very brief introduction to the subject. Even then there appears to be some difference of opinion as to the utility of the method, probably because the authors have had little or no practical experience with photographic work and are not personally familiar with the conditions, physical or climatic, under which much of the work must be carried on. Nevertheless photographic methods became firmly established a long time ago and afford the most accurate and economical means of mapping certain classes of country.

In actual work the photographs are really perspectives and from these the map is constructed. The principles involved were first suggested by J. H. Lambert, of Zurich, 1759, but no effort to apply them practically was made until 1791-3 when Beauteemps Beaupre made the first attempt, using a series of freehand sketches of the coast region of Tasmania and Santa Cruz island. Although himself convinced of the feasibility of the system, he failed to convince others, probably on account of the difficulty of making freehand drawings sufficiently accurate for the purpose, and so the method was practically forgotten.

In 1839, Arago called attention to the possibilities of utilizing photography and in 1849 Captain Leblanc made an attempt to apply it to French military surveys. All early attempts were much hampered by the slowness and uncertainty of the early photographic process, and by the heavy and cumbersome apparatus required. In 1850 Col. A. Laussedat (who was practically the father of photographic surveying) began a study of the subject using at first a "camera clara" for obtaining the necessary perspectives, tracing the outlines by hand. For some years he continued this work, improving the instruments and elaborating the methods, and when a suitable lens was obtained, substituted photographs in place of freehand drawings. In 1859 he felt justified in announcing his success to the Academy of Sciences in Paris, and after a careful and critical examination, a favorable report was made, and photographic surveying passed from the experimental stage and became a recognized science. Since that time it has made rapid strides and has been used extensively in many European countries and also in many other parts of the world.

The introduction of photographic surveying into Canada was due to Dr. E. Deville, Surveyor General of Dominion Lands, a man of high scientific attainments. He was quick to realize its value for mapping the extensive mountain regions of Western Canada and himself designed instruments which he considered specially suitable for the requirements. These instruments are still in use, almost in their original form, though minor alterations have been made and modern lenses have replaced those originally used in the cameras. In addition he wrote an exhaustive treatise entitled "Photographic Surveying" dealing with the subject from both a theoretical and a practical standpoint. Unfortunately only a limited edition was published and the book has been out of print for many years. In 1886, J. J. McArthur, with a small party, was sent out to commence a topographic survey of that part of the Rocky Mountains adjacent to the Canadian Pacific Railway. This work was continued for about seven years and although largely experimental in its early stages, was very successful and Mr. McArthur was able to map an area of about 2,000 square miles using a scale of 1/20,000 and a contour interval of 100 ft. Since that time many other extensive surveys of a like nature have been made in Canada by the Surveyor General's branch and also by other government departments.



FIGURE 1

Note:—Points A and B are located respectively at the right and left hand of illustration. P is at the intersection of horizontal and vertical lines.

*Paper read before the Fifteenth Annual Convention of the Association of Dominion Land Surveyors.

Photographic methods are not applicable to every class of country. It is necessary that there should be bare summits suitable for stations, and that there should be sufficient relief to permit the ready identification of the same points

on views from different stations. Consequently the camera cannot be used in districts where all the hills are heavily timbered. Considerable work has been done in foot-hill districts where occasional bare points can be found, and where views in one or more directions can be obtained by partially clearing off other summits occupied. Owing to

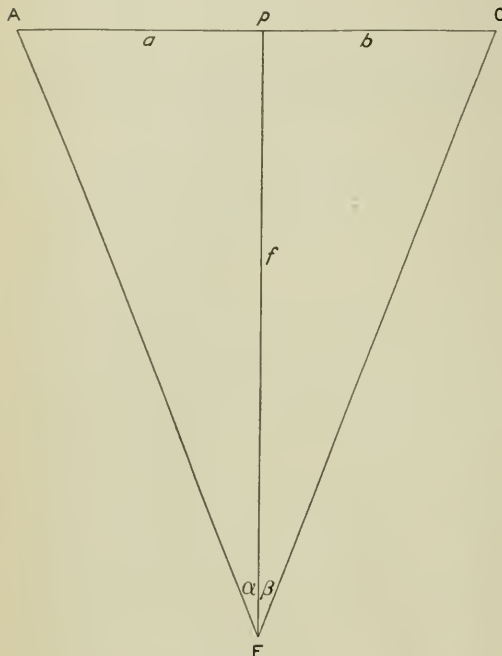


FIGURE 2

the difficulty, often impossibility, of getting stations where most needed and the absence of pronounced topography, the results are not entirely satisfactory. Still a very fair map may be made showing all the main features and much of the detail, and when criticizing, it should be remembered that it is a difficult and expensive matter to accurately map country of this nature by any other method. It is, however, in the higher mountain ranges that the camera can be used to the greatest advantage. Here there is no difficulty in obtaining stations and the mountains with their bold rugged outlines afford much better photographic subjects than the rolling foothills. In addition to this, mountain views usually cover a greater area and the identification of points may be accomplished much more rapidly and accurately than when dealing with less broken country.

Light Transit Used

On Canadian photographic surveys the essential instruments are a small transit and a camera. These instruments are of the simplest possible form so that there may be no complicated adjustments to get out of order.

The transit is a light instrument of the ordinary pattern made by Troughton & Simms, London, England, with 3-in. circles reading to minutes. The tripod has extension legs, 3 ft. 4 in. long when extended and 20 in. long when closed. When in use, a bag is suspended between the legs, and filled with stones, and then the legs and bag are blocked with more stones so that the tripod may be rigid in any wind. For packing, the tripod head is taken off and placed in the transit box, and the legs are placed in the back of a canvas case designed to hold both the box and the legs.

This case is fitted with shoulder straps for carrying and with the instrument and tripod weighs about fifteen pounds.

The camera consists of an oblong metal box open at one end and fitted into a strong outer wooden box case made of mahogany. The metal box carries the lens and two sets of cross-levels which may be read through openings in the outer case. Inside the metal box there are two sets of diaphragms to intercept any light which does not contribute directly to the formation of the image, the whole interior is blackened and as a further precaution, a shade is placed over the lens when exposing a plate. The back of the outer case is movable and is so arranged that when a plate is inserted in the camera it can be screwed in against the holder so that the plate is firmly held against the open end of the inner box, thus insuring that the plate is always in the same position relative to the lens. The instrument stands on a three-screw base similar to that of the transit, so that both instruments may be used on the same tripod. The camera may be used with the long side either horizontal or vertical. In the horizontal position the lens has a field of about 51 degrees and in the vertical position a field of about 37 degrees, the extent in either position being shown approximately by lines ruled on the case. The size of the plate is $4\frac{3}{4} \times 6\frac{1}{2}$ in. The carrying case is designed to hold the camera and twelve single plate holders and is fitted with shoulder straps. The total weight of the case with the camera and twelve plates is about twenty pounds.

In order to use the camera certain conditions are necessary. The plates, while being exposed, must be in a vertical plane, the position of the horizon and principal lines must be known and also the focal length of the lens. While these determinations may be made separately and by different methods, the writer has found it advantageous to make all of them at the same time, and to always make measurements by which the focal length of the lens may be computed, even though using the same lens from year to year. This means little extra work and affords an independent method of checking the focal length of the enlargements used in plotting as the contraction or expansion may vary in different lots of paper.

Tests for Focal Length

To make these tests, a place is selected where several points of about the same elevation may be found. This is usually a level meadow or a small valley. The camera is set up in a horizontal position and a level or transit placed a short distance away, so that the telescope of the latter is on the same level as the centre of the lens. Fig. 1 shows the transit placed in position. Then some distance away three targets, A, B and C are placed on the same level and

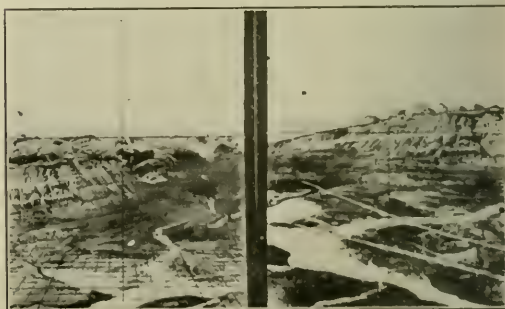


FIGURE 3

in such position that the two outside ones, A and C will be just inside the field of the camera when horizontal and A and B just inside the field when in the vertical position. A specially prepared mirror, long enough that the end projects about 4 in. beyond the camera, is then inserted and screwed up firmly against the inside case in the exact position oc-

occupied by the plate. The camera is turned until the reflection of one of the signals can be seen through the telescope and it is then tilted forward or backward by means of the foot screws until the horizontal hair of the telescope bisects the image of the target, the transverse level being kept in its centre position throughout. The mirror is then

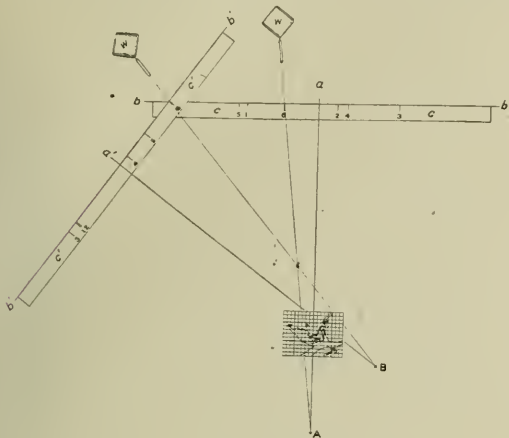


FIGURE 4

in a vertical plane and the position of the bubble parallel to the axis of the camera is carefully noted. The mirror is removed, and with the camera very carefully levelled, one or more views are taken showing the transit and the three signals. After this the camera is set up in its vertical position and the mirror replaced. By shortening the legs of the tripod, the camera is lowered until the mirror shows above when viewed through the telescope and the position of the other bubble when the plate is vertical is found as before. When this is completed the mirror is removed and the camera raised until the lens is again level with the telescope, and other plates are exposed in the vertical position showing the signals A and B.

For the determination of the focal length, the transit is then moved to the position occupied by the camera and the angles subtended by the three signals are carefully read.

In making use of this information, the plate itself may be taken or the plotting enlargement. In either case the procedure is practically the same, but it is easier to work on the enlargement and that is really of more vital importance to the topographer than the negative. If several enlargements be used they will give practically the focal length for use in plotting as the contraction is not likely to vary much with the same lot of paper. This however, cannot be taken for granted and the dimensions of the enlargements must be carefully watched.

It is now necessary to determine the horizon and principal lines. On one of the horizontal views draw carefully a fine line through the centre of the targets A, B and C (Fig. 1) and then do the same on one of the vertical views. These lines represent the horizon lines for their respective views. Take the horizontal view and by means of the notches VV transfer the line from the vertical view and find P, the intersection of the two lines. This is the principal point of the view. Through P draw a line VV perpendicular to the horizon line. This represents the principal line of the view and if all levels are in proper adjustment, should coincide with the vertical line as transferred from the second, though this condition is by no means necessary. The vertical view is then treated in a similar way.

Determination of Focal Length

To determine the focal length, the distance from the signals A and C to the principal point P must be very carefully measured. The focal length is then found as follows:

Let the distances A to P and C to P (Fig. 2) be a and b respectively. Let PF represent the focal length f and let α and β be the angles AFP and CFP and let $\alpha + \beta = \theta$. All these are known angles, measured in the field.

Then $\tan \alpha = a/f$.

$\tan \beta = b/f$.

$\tan \alpha \tan \beta = a b / f^2$.

$\tan (\alpha + \beta) = \tan \theta = (a/f + b/f) / (1 - a b / f^2)$.

From this we have a simple quadratic equation,

$f^2 - [(a + b) / \tan \theta] f - a b = 0$,

which, when solved, gives

$f = (a + b) / 2 \tan \theta + [(a + b)^2 / 4 \tan^2 \theta + a b]^{1/2}$

Determinations of the focal length should be made for both positions of the camera as the contraction of the paper in different directions may vary.

Plates For Alpine Work

Photography in Alpine districts, particularly in the higher ranges, presents many difficulties. There are snow peaks glistening in the sunlight and deep heavily timbered valleys partly in shadow and often filled with a bluish haze due to atmospheric absorption and diffusion of light. Moreover the diffusion of light causes the more distant points to become indistinct, the landscape gradually merging into a uniform tint, an effect known as "aerial perspective." Now survey photographs must be clear and full of detail so that the points to be plotted may be well defined and easily identified. Hence to obtain satisfactory views, it is necessary to use plates which have great latitude of exposure and which give, so far as possible, a correct rendering in monochrome of all different colors. The plate used for some years on Canadian topographical surveys is the Wratten and Wainwright Panchromatic plate which is used with a yellow screen made by the same company, and known as a "C" filter. This make of plate is sensitive to all rays of light and when used with the screen, which reduces the effect of the more actinic part of the spectrum, i.e., the ultra violet to blue rays, has given excellent results. To prevent halation, or diffusion of light from the back of the glass, the back of the plate was formerly covered with a black substance in optical contact with the glass, but during the last season a double emulsion has been used instead. This means that the sensitized film is of sufficient density to absorb all light falling upon it during exposure and to prevent any light penetrating to the surface of the glass. Owing to their extreme sensitiveness, these plates must be handled in the dark not only in the field but also in the developing room. Because of this, there is no opportunity for controlling the development and the matter of correct

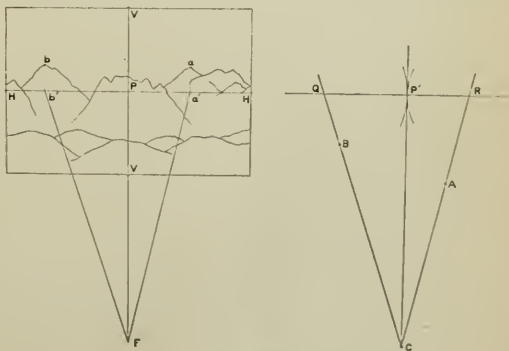


FIGURE 5

and uniform exposure becomes an extremely important factor.

There are many difficulties encountered in the field among the first of which are those involved in climbing. On the lower slopes there is dense underbrush and windfall to struggle through, and higher up snow

slopes and glaciers to cross, rock cliffs to climb and difficult aretes to traverse. On the summit the surveyor must work with an instrument set up on a pile of loose rock on the most exposed part of the peak, frequently suffering severely from cold and wind while doing so. These however are minor difficulties and not nearly so serious as those due to

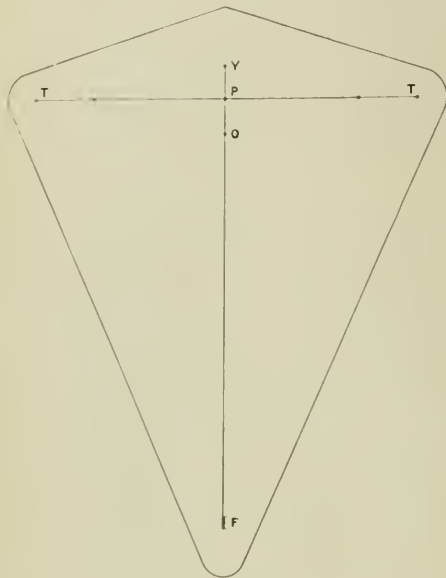


FIGURE 6

variations of light and sudden changes of weather. The surveyor cannot wait indefinitely for a suitable light but must use his own judgment regarding exposure. This is a difficult matter when cloud shadows are heavy, particularly in a country where there is but little contrast. Even on a fine day, some views may require three to four times as much exposure as others. Often it is necessary to work rapidly in order to get through before an approaching storm breaks, or before clouds roll over the peaks and render further work impossible. Other causes of much trouble, particularly during the latter part of the season, are smoke from forest fires, dense haze and early snow storms. In these circumstances the surveyor must decide under what conditions he can work profitably and this depends very largely on the nature of the district. In Alpine country or where valleys are narrow, serviceable views may be obtained under very unfavorable circumstances, but in rolling country or where great distances are involved, objects soon lose their distinctiveness. Good photographs can be obtained only under favorable circumstances but much of a surveyor's success depends on his ability to get serviceable photographs under varying adverse conditions.

When in the field it is important to select those points which give the best views of the surrounding country. This does not mean that the highest peaks are always the best. In photographs taken from very high peaks the surrounding country often appears dwarfed and the detail does not show up so well as in those taken from a more moderate elevation. It must also be remembered that the higher the peak the longer the ascent will require, and the greater the likelihood of encountering sudden storms or floating clouds. Frequently very useful views may be quite easily obtained, from points of comparatively low altitude.

Cover Circuit of Horizon

It is customary to take enough views from each peak to cover the complete circuit of the horizon. This means

very little more work for the surveyor in the field and the extra views are often of assistance in the office. It seldom happens that all the views can be taken from a single point, and usually one or more camera stations are required on different parts of the peak. As a rule these stations may be located by reading angles on them from the main station and measuring the distance with a light tape. Angles must be read on at least one well defined point in each view, preferably on two. The angle of elevation or depression should also be read on each point as it may serve to check the horizon line of the view, if there should be any trouble in the office. It must be remembered constantly, throughout all field work, that the country to be mapped must be seen from at least two points which subtend angles great enough to give satisfactory intersections, and not too great to permit easy recognition of the same points as they appear in corresponding photographs, taken in pairs, one from each station.

For plotting purposes, bromide enlargements approximately 10 x 14 in. in size, are made from the negative. To obtain satisfactory results, the enlarging must be accurate, and uniformly done. This work is done by the Department at Ottawa with an enlarging camera constructed specially for the purpose.

In the office, the triangulation is plotted by ordinary methods depending on the nature of the control. This may vary from a precise triangulation to a reconnaissance survey where the triangulation and the photography are carried on at the same time. The elevations of the stations and more prominent peaks are computed from the angles read in the fields, the necessary corrections being made for curvature and refraction.

Views from different stations, showing the same country, are then selected. Sufficient points are identified on the corresponding views to show clearly the topography of the country. These points are plotted on the plan and their elevations calculated from the photographs. Using these points as a guide and with the photographs in front of him, the topographer is able to draw his contours with an accuracy dependent chiefly on the number of points plotted and the scale of his plan.

Figure 3 represents views from different stations shown as A and B on Figure 4. On these views points 1 to 6 have been identified to show the method used in plotting. The horizon and principal lines are ruled on the views in their proper positions as shown by the test views. The traces

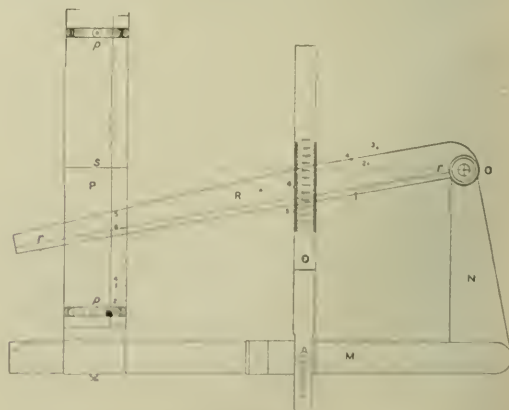


FIGURE 7

of the principal lines and the picture planes are then laid down as shown in Figure 4. The lines from the stations A and B, to a and a' represent the principal lines of the views and b b' and b' b' represent their respective traces. The distances of the points identified from the principal line are then taken off on a slip of paper, using a separate slip

for each view. These slips c and c' are placed on the proper traces as shown in the illustration. The line of sight to any point is given by drawing a straight line from the station to the projection of the point as shown on the slip and the position of the point as given by the intersection of two or more of these lines of sight. Instead of drawing lines on the plan, it is customary to insert needles at the stations and to determine the intersections by means of fine threads or hairs attached to small weights. In Figure 4 these weights are represented by w , w , and the hairs shown at the point 6.

The geometric construction for laying down the traces is as follows:—

Let A and B , Figure 5, represent two known points either triangulation stations or points to which angles have been read by the transit. Produce the principal line VV to F making PF equal to the focal length. Find the projections a' and b' of a and b on the horizon line and measure the distances Fa' and Fb' .

In the second part of the diagram C represents on the plan the station from which the view is taken and A and B the two points. Draw lines from C through A and B and make CR and CQ equal to Fa' and Fb' respectively. With R and Q as centres and radii Pa' and Pb' respectively describe arcs of circles as shown. Draw CP' and join QR . Then P' is the projection of the principal point and QR is the trace of the picture plane. If there is any inaccuracy in the location of the stations or in the other work the two arcs will not be tangent to each other and the mean position will have to be used.

In order to facilitate the laying down of traces several methods have been devised. One of the best of these methods is due to R. D. McCaw of British Columbia. In this method a piece of celluloid is cut as shown in Figure 6 and two lines TT and FY drawn at right angles, PF being made approximately equal to the focal length. A small slot is cut at F and a scale ruled to cover variations in the focal length. The instrument is placed on the view and the distances of the points as a and b Figure 5 from the principal line marked on the line T with ink. The instrument is then transferred to the plan and using the proper focal length as shown by the scale it is rotated around C , until the points marked, which correspond to a' and b' , fall in Q and R . The position of the principal line is pricked through by means of the holes shown at O , P and Y and the position of the trace by means of those at T or in the case of a vertical view of those shown a little nearer the centre. The temporary marks are then cleaned off with a damp cloth. It will be readily seen that this method corresponds with the one given previously.

Determine Elevation of Points

The elevation of the points are determined by means of the instruments shown on Figure 7, which was originally devised by Messrs. D. B. Dowling and H. Matheson of the Canadian Geological Survey. The arms M and N are of brass fastened rigidly together. P and Q are sliding bars moving on the arm M . R is a swinging arm revolving around the centre of O ; P and R are made of transparent celluloid and on R a fine line rr is ruled radiating from the centre O . The arm Q carries a scale corresponding to the scale of the map. The instrument must be made accurately so that when the line rr is over the line s , the reading of the scale will be constant when moved along the arm M .

When using the instrument the centre O is placed over the station, and the arm P is placed so that the one edge coincides with the trace of the view, the line s falling on the principal line. The instrument is then held in place by heavy paper weights. The distances of the points above or below the horizon line as shown on the views is taken off on a slip of paper. The slip is placed on the arm P as shown in the diagram and held in position by the clips p . The scale is now set to read the elevation of the station when the line rr is above s . To obtain the elevation of the point 6, the arm Q is moved to the point plotted and the arm R moved so that rr passes through 6 as shown on the slip. The elevation of the point is now given by the

reading of the scale where it is intersected by rr . To avoid mistakes the elevation of each point is taken from two views and the mean of these two elevations is used.

Relatively level features such as swamps, lakes or rivers with comparatively small fall are plotted by means of squares. The perspective of a series of squares is laid down on the view and the projection on the proper scale, drawn on the plan. Then from the view the required features are drawn on the projection, square by square, as carefully as possible. It is necessary that the squares should be small enough to give good definition. In practice these squares are not ruled on the views but an instrument called the perspectometer is used instead. This consists of the perspective of a series of squares ruled on glass, having the distance line equal to the focal length of the photograph. It is customary to make the sides of the squares equal to one tenth of the difference in altitude between the station and the features to be mapped, though this may be varied to suit circumstances. The instrument is placed in its proper position on the view and the features drawn as before. The perspective of a set of squares is shown on the first view of Figure 3, and their projection, with the topography drawn in is shown in Figure 4.

Factors for Accurate Photographs

The accuracy of a photographic map depends first of all on the precision of the triangulation system controlling the survey. After that it is dependent on the number of camera stations and on the scale of the plan. Any scale or contour interval may be used. For general purposes the writer considers a contour interval of 100 ft. and a scale of 1:40,000 very convenient for a large plan. The precision is that of a good plane table survey but with the advantage that many more points are plotted and the contouring is done by the surveyor in the office, with views from different stations continually before him, while with a plane table this comparison is entirely wanting.

The most tedious and tiresome part of the work is plotting the points and drawing the contours. The office work requires at least twice as long as the field work. However, the time required for the field work which is the most expensive, is much less than if any other method of survey were employed and consequently delays due to adverse conditions are reduced to a minimum. The office work is carried on by a small staff and under favorable conditions, and is not so subject to unexpected interruptions.

A party of seven can work to good advantage under most circumstances. The party consists of the surveyor, his assistant and five men, two of them should be expert packers, if pack horses are used. With two sets of instruments, the surveyor and assistant surveyor, each accompanied by two men are free to work in different localities, the cook being left in charge of main camp at some central point. Except on long or dangerous trips one man is enough to accompany the surveyor when actually climbing. If in a country unusually difficult of access, extra help may be necessary, and even under ordinary circumstances an extra man is often an advantage.

With regard to the future of photographic surveying, it is probable that owing to the nature of the country to which it is applicable, the demand for work of this kind will always be rather limited. There are very large mountainous areas in Alberta and British Columbia which can be satisfactorily mapped in this way and other less broken areas, some partially timbered, which may be mapped by the camera alone or by the camera used in conjunction with other methods. While this class of country will not develop with a rush, as the prairie did a few years ago, its development will be gradual and there will be an increasing demand for topographic maps until ultimately it will all have to be surveyed. So far the work has been confined to government surveys of large areas on a small scale, but it is probable that as the method becomes better known, it may be found a rapid and accurate means of obtaining the topography of small broken sections on a large scale. Should such be the case, its field of usefulness would be greatly extended.

HYDRO-ELECTRIC POWER SITUATION AT ST. JOHN

Dependability of Supply Offered by New Brunswick Electric Power Commission Questioned by R. A. Ross & Co. in Report to City — Reply by Power Commission Engineers

ADVICE with respect to entering into a contract with the New Brunswick Electric Power Commission for the supply of power to the city of St. John, N.B., was recently sought by the city from R. A. Ross & Co., consulting engineers, Montreal. The report which has been received and published may, in the main, be characterized as adverse.

The present situation grows out of an effort that has been made to secure an arrangement with the commission more favorable than is now in force with the New Brunswick Power Co., the present distributors of power and light in St. John. In brief the offer of the commission is to furnish power at the city line for 1.2 cents per k.w.h. for the first four years and for 0.8 cent per k.w.h. thereafter, provided the city will agree to pay for a minimum of 10,000,000 k.w.h. It is planned to obtain this power from the Musquash development of the commission.

Ross Report in Brief

The outstanding features of the report of R. A. Ross & Co. are stated by Mr. Ross as follows:

(1) On the basis of the gauging records the power available at St. John during a year of minimum precipitation will be 17,000,000 k.w.h.

(2) As the gaugings show such extraordinary results when compared with the precipitation they cannot be accepted with safety.

(3) On the basis of the precipitation records, the power available at St. John during the year of minimum precipitation will be not in excess of 9,000,000 k.w.h.

(4) As the yearly operating and fixed charges which are a constant when divided by the k.w.h., the latter is indeterminate owing to the doubtful output.

(5) The requirements of the present customers of the company for light and power and street lights total 6,250,000 k.w.h.

(6) The total requirements of the company for 1920 totalled 12,113,490 k.w.h.

(7) The capital cost of a new distribution plant and steam standby station to cover light and power and street lighting is \$1,594,432.

(8) The cost per kilowatt hour to the customer from a new civic distribution plant covering all customers of the power company will be 7.99c. per k.w.h.

(9) The high cost of light at St. John as compared with Brantford, Hamilton, London, Windsor, is accounted for by the high cost of construction at present, and the necessity for a steam standby, but above all the restricted use per customer in St. John. On the same basis as above cities in these regards the cost per k.w.h. at St. John would be:

Basis of Brantford, 3.50c. per k.w.h.
Basis of Hamilton, 2.90c. per k.w.h.
Basis of London, 2.70c. per k.w.h.
Basis of Windsor, 3.50c. per k.w.h.
On report basis of St. John, 7.99c. per k.w.h.
Actual for 1920 basis of St. John, 8.55c. per k.w.h.

(10) The cost of power compared with Niagara is too high and the amount too restricted to permit obtaining loads common in Ontario, thus utilizing the distributing system for many hours per day instead of a few hours at night as at present, with consequent reduction in cost per k.w.h. for all services.

Musquash Development

The power to be supplied St. John is to be obtained from a development on the Musquash river covering both

east and west branches, the outstanding features of which are given in Table 1.

Table 1

	East Branch	West Branch	Total
Tributary drainage area in sq. mi.	72	76	148
Static head on wheels	95	117	Av. 102
Capacity of wheels k.v.a.	2-2900	1-2900	8700

Under the above 102-ft. head and with a generator efficiency averaging 90% and a wheel efficiency at 80%, which seems fair when considering the fact that on the St. John demands the load factor of the operating machines will be for many hours 33% or less, the number of cubic feet of water at the wheels necessary to generate one k.w.h. is 579 cu. ft.

The commission have in contemplation the supply of 21,000,000 k.w.h. at St. John. Assuming 10% loss in switching, transmission and transforming, the generated output at the Musquash would be 23,333,333 k.w.h. Total k.w.h. generated per square mile will, therefore, be 157,000. To supply the necessary wheel water for this amount of power would require a depth per square mile of run-off gathered at the wheels of 3.26 ft. or 39.12 in.

Stream Gaugings

In this district there are three contiguous drainage areas tributary to the Magaguadavic, Lepreau and Musquash rivers upon which gaugings have been made to determine the available flow. The general characteristics of these areas are as in Table 2.

TABLE 2

Run-off of Certain Streams in New Brunswick For Years Ending September 30.

		Magaguadavic	Lepreau	West Musquash
	Drainage area to gauge sq. mi.	574	90	76
1919	Mean run-off; second feet	1257	299	.....
	Run-off; second feet per sq. mi.	2.19	3.32	.....
	Run-off; depth in inches	29.78	45.30	.....
1920	Mean run-off; second feet	1442	309	.....
	Run-off; second feet per sq. mi.	2.51	3.43	.....
	Run-off; depth in inches	34.05	46.59	.....
1921	Mean run-off; second feet	1147	248	187
	Run-off; second feet per sq. mi.	2.00	2.75	2.46
	Run-off; depth in inches	27.18	37.55	33.60
	Average depth run-off for period, inches	30.3	43.1	.....

It will be noted that the West Musquash has only been gauged for a year and the East Musquash practically not at all. The item which attracts immediate attention in comparing these areas is the high run-off of 43.1 in. from Lepreau as compared with 30.3 in. on the Magaguadavic. When it is considered that these three areas are all subjected to the same climatic conditions including rain-fall, it is difficult to account for this difference even when allowance is made for the increased size of the Magaguadavic watershed and its reported different character. Further, it will be noted that even the Magaguadavic has a high run-off as compared with similar streams as will be shown later. It should be stated also that the records of Lepreau for the year 1919 only were used to design the Musquash plant for which no record then existed, and that the latter is now showing a considerable reduction on gaugings being taken.

In this and following tables it may be stated that all the figures of gaugings, etc., quoted, have been obtained from the Water Power Branch of the Dominion Government and are therefore authentic.

Precipitation Records

As the percentage run-offs indicated by gaugings in this district when compared with hundreds of others reasonably comparable and reliable has never been reached before,

the question of precipitation must be brought into the discussion.

It must be remembered that up to a few years ago, the only information engineers had as to stream run-off for use in the development of water powers, was obtained from the records of precipitation taken by the Dominion government at various stations throughout the country; and while it is recognized that accurate and seasoned gauge readings are more acceptable, under the extraordinary conditions shown in these gauging records, actually taken for only a short period, a comparison at least must be made between these two sources of information.

In Table 3 the precipitation records in the district for the years 1919-20-21 are given, from which it will be noted that those at St. John have been recorded for fifty-nine years; also that record is the highest in the district, and if applied to the drainage areas in question will undoubtedly allow a higher precipitation than the district actually received, those from the surrounding stations being less, and generally very much less. Further, this record being kept at the headquarters of the Meteorological Bureau for this district under the eye of the director, and for a period of fifty-nine years, may well be considered a model.

TABLE 3

Rainfall Records at Certain Places in New Brunswick for Years Ending September 30.
Depth in Inches

	Point St. John Lepreau	Sussex	Moncton	Fredericton Experimental Farm	Fred- erick- ton	
1919	51.44	49.76	37.77	40.10	35.82	41.79
1920	52.41	53.53	48.97	36.67	34.93	50.15
1921	35.28	37.87	31.42	26.84	29.41	33.73
Mean	39.73	47.47	38.78	34.99	37.01	43.03
Years in- cluded in mean	17	59	18	18	8	15

With the rainfall at St. John as a basis, the run-off gauging records compared with the rainfall records during the same year are shown for both Lepreau and Magaguadavic for a total of three years, and with the Musquash for one year only in Table 4.

The notable point in connection with this table is that under the same climatic and precipitation conditions the run-off of Lepreau is 42% higher than the Magaguadavic, all, of course, on the square mile basis. Further, Lepreau shows records up to 99% of the rainfall, a thing incredible, while the average over three years is 92%.

The records of the Magaguadavic on the other hand are more reasonable, although high, averaging 64%.

TABLE 4

Run-off Compared with Rainfall Precipitation
West Magagua-

	Lepreau	Musquash	davic	St. John
Mean run-off inches 1919	45.30	.....	29.78	49.76
Mean run-off inches 1920	46.59	.....	34.05	53.53
Mean run-off inches 1921	37.55	33.60	27.18	37.87
Total run-off 3 years	129.44	.....	91.01	141.16
% Run-off to rainfall '19	91%	.....	60%	.....
% Run-off to rainfall '20	87%	.....	63%	.....
% Run-off to rainfall '21	99%	89%	71%	.....
Mean for 3 years gauging	92%	.....	64%	47
Comparative % of run-off	142%	.....	100%	.....

When these gauging records are compared with those from other streams on the Atlantic seaboard, although not in this country, reported upon by the U. S. Geological Survey, the contrast becomes startling. For the purpose of illustrating this, the records of eight streams as nearly as possible similar in area have been selected for comparison. These records as they have extended for a long period have been discussed by the engineering profession have become almost classics, and are accepted as correct. It will be noted the percentage of run-off in every case is very much lower

than the Magaguadavic, and tremendously lower than Lepreau.

TABLE 5
Mean Rainfall and Run-off Small Areas

Atlantic Drainage	Years	Area	Rain Ins.	Run-off	Runoff %
Croton	23	339	49.4	22.8	46
Cochituate	38	19	47.1	20.3	43
Sudbury	26	78	46.1	22.6	49
Mystic Lake	18	27	44.1	20	45
Neshaminy	16	140	47.6	23.1	50
Perkiomon	16	152	48.0	23.6	49
Tohickon	15	102	50.1	28.4	57
Pequanock	9	64	46.8	26.8	57
Magaguadavic	3	574	47	30.3	64
West Musquash	1	76	37.87	33.6	89
Lepreau	3	90	47	43.2	92

Under these conditions of wide discrepancy between gaugings of short duration and the old and seasoned record of rainfall at St. John, and by comparison with similar areas elsewhere, it is inevitable that for safety in prediction as to the power available one must return to the rainfall record.

The question upon which judgment must be used is as to the percentage of rainfall which may be expected to appear at the wheels in the way of run-off, especially realizing that this water is not in its free state, but is ponded, and therefore evaporation and seepage are inevitably high.

In Table 6 below, the percentage run-off at maximum is allowed at 66 2/3% of the rainfall of the year; the minimum 45%, and the average over fifty-nine years 55%.

In these allowances the fact is recognized that there will be more percentage run-off during a high precipitation year than during a low. As these percentages are higher than one would care to use for the purpose of predicting the amount of power available in advance of construction, especially when it is considered that all water in this case is to be stored, the results are considered to be such as to do to the power output no injustice but rather the reverse.

TABLE 6

Output on Basis of Rainfall Records at St. John for 59 Years	Maximum	Minimum	Mean
Based on Rainfall Alone	1886-87	1910-11	1861-1920
Extreme and mean rainfalls	58.51	36.70	47.47
Rainfall inches per year	66 2/3%	45%	55%
Allow % in run-off	39	16.5	26.1
Run-off in inches			

Power Available at St. John

In a previous page of this report it was shown that a depth of run-off of 39.12 in. was necessary to provide 21,000,000 kilowatt-hours at St. John, while gaugings on the West Musquash for 1921, indicate a run-off of 33.60 in., during which time the St. John precipitation records amounted to 37.876. This is not by any means the lowest rainfall record at St. John, that of 1910-11 being 36.70 in., from which, if we assume a proportioned run-off the lowest gauged record should give 32 in. of run-off.

The minimum power available at St. John during the year of lowest rainfall recorded at St. John would therefore be 21,000,000 k.w.h. multiplied by 32, and divided by 39 = 17,000,000 k.w.h. On the same basis, the other records in Table 6 show the following:

TABLE 7.

Power Available at St. John

	Run-off In.	Power at St. John k.w.h.
From gauging records, the lowest power available in 59 years	32	17,000,000
By precipitation readings maximum run-off (table 6)	39	21,000,000
By precipitation readings mean run-off (table 6)	26.1	14,000,000
By precipitation readings minimum run-off (table 6)	16.5	9,000,000

If the gauging records are right St. John may expect from the Musquash 17,000,000 k.w.h. during the minimum year. If these are not found to be correct and the precipitation records govern, it cannot be predicted that more than 9,000,000 k.w.h. will be available as a minimum. This will cover the present requirements at St. John for light, power and street lights in all totalling 6,250,000 k.w.h., but it will not cover the requirements of the company which include in addition those of the street railway, in all 12,000,000 k.w.h. in 1920.

Should it develop that the Musquash does not come up to the commission's expectations, or even if it does, a steam plant would be advisable to supplement the water power and enable the output of the project to be greatly increased over the minimum, so that new hydraulic plants when developed will not have to remain unloaded or only partially loaded for years after construction.

This steam plant, supplementing as it should the hydro-electric plant, should be owned and operated by the government so that they may carry out their own program of use of water and catch every flush as it comes, using the steam station to keep the pondage up during critical periods, and to carry the peaks of whatever service is demanded either from St. John or elsewhere. This question of a steam

average for the year, or \$8,922, has been used to determine the average operating costs.

Capital Cost of Distribution

Two methods of estimating the capital cost of distributing light, power and street lights are available.

An actual map layout with centres of distribution, loads, etc., marked, may be used, from which the number of transformers, meters, poles and weight of copper, etc., may be estimated. This is a long and expensive process, but fortunately there is a better one, as the results of actual practice are available.

A study of the records of the Hydro-Electric Power Commission of Ontario indicates that there are four cities, which may reasonably be used as a basis for estimating the capital cost for St. John—these being Brantford, Hamilton, London and Windsor, chosen by reason of similarity of customers and loads to those existing in St. John. It should be noted that for this purpose distance from the centre of generation has no bearing on the results which are limited entirely to local distribution costs within these cities covering land, buildings, appurtenances and street distribution as shown in Table 8 with the final figures obtained and used for St. John, inserted in 5th column.

TABLE 8
Capital Costs of Distributing Plant

	Brantford	Hamilton	London	Windsor	St. John
Population	32,159	108,143	59,100	31,629	60,000
Customers light and power	3,973	20,067	13,793	6,103	9,107
Capital cost light and power	274,262	1,190,867	1,022,894	315,836	887,932
Capital cost street	79,538	207,701	224,694	262,574	247,500
Capital cost total	353,820	1,398,568	1,247,588	578,410	1,135,432
Capital per Customer	69.00	59.00	78.00	52.00	65 + 50%
Operation and maintenance customer	5.75	5.90	7.00	6.70	6.33
K.W.H. per light customer	500	600	650	500	345

plant is dealt with fully in the second part of this report, and is there charged to the cost of distribution but should in justice be debited against the power purchased.

The serious part of this question relates to the cost per kilowatt-hour which has to be charged to someone. With an anticipated output of 21,000,000 k.w.h. which must, of course, be reckoned on the lowest year, unless a steam plant be provided, the cost can be met at the rate of 1.2 cents per k.w.h.

By whatever amount the sales fall below the above output, the cost per k.w.h. will increase in inverse proportion and must be paid by someone.

SECTION 2

Cost of Power to Customers

The question to be answered under this heading is as to the cost of light and power delivered to the customer on his premises in the city of St. John from energy purchased from the New Brunswick Electric Power Commission at their sub-station near the city at a cost of 0.8 cents per kilowatt-hour with a minimum of 10,000,000 kilowatt-hours to be paid for.

Power and Light Requirements

It is a very difficult thing to predict what the number of customers and their consumption per year is likely to be where no records exist. Fortunately in this case, we have the figures of the very admirable report of Mr. Kensit, supplemented by additional records of the company obtained since the issue of that report from which demands of the customer can be ascertained, and the power required to meet those demands at the commission's sub-station arrived at. The total of the company's station output for 1920 was 12,113,480 k.w.h., the total power demands for light, power and street lighting being 6,250,000 k.w.h.

Customers

The number of customers of the company for December, 1921, was 9,107, this being used for estimating the capital involved in supplying this number of customers, while the

The items of capital cost shown herein are obtained from the records of the Ontario Hydro-Electric Power Commission; the division between street lighting and light and power being arbitrary as regards several undivided items of the cost, but in every case they favor a low capital investment in the light and power distribution.

It will be noted that the capital investment per customer is not very different in the four cities considered, and that the average, which is \$65, has been used as a basis for estimating the capital cost of the distributing system for light and power only in the city of St. John.

Inasmuch as the capital invested in the distribution in those cities was made before the present rise in prices, an arbitrary percentage of fifty has been added in the case of St. John, to allow, in the first place, for the increase of cost during the last few years, and to, in some degree, anticipate the excess costs which will be incurred in St. John, owing to rock holes necessary for pole placements, and the difficulties which are inevitable in constructing power lines throughout the city, over, under or through the live wires of the company presumed to be a competitor.

In the same table will be found the operating and maintenance costs in these different municipalities, in which the bookkeeping is identical, and the results therefore directly comparable. Further figures at the end of the table indicate the average yearly demand per customer as compared with St. John's. It will be emphasized later that this lack of use is very largely the reason for the high cost in the latter.

From the above study, the capital costs of the entire undertaking are found. This, including the capital cost of distribution at \$65 per customer plus 50%, and for three miles of transmission line from the company's sub-station to the city, the whole making a total chargeable to light and power only of \$917,932.00.

In addition, the street lighting capital costs proportioned from the above four cities on the basis of ratios of heads of population is estimated with the same advance in their

price, and the cost of a steam station, details of which are given below.

It will, therefore, be seen that the capital investment necessary for the distribution of domestic and commercial light and power with street lighting up to and including the meters on private premises, will amount to \$1,594,432.00.

Steam Station

In the case of St. John depending as it will upon stored water from two small streams of limited capacity, a steam station is not only an insurance against breakdown, but a positive help in sustaining the output of the water power plant at a higher figure than the commission would dare to attempt if a steam plant were not in existence. It will also enable the city to accumulate a load in advance of the contemplated construction of the Lepreau plant, and thereby ensure a commercial return from that plant when completed. Otherwise, as the cost of the Lepreau must be charged to someone, the city will be involved at the start with a new plant which can only be loaded up gradually from increased demands in the city as they appear, the inevitable result being a very much higher cost for power to the city until the new plant is loaded.

From the point of view of insurance therefore against shut-down which would be fatal in the case of a city the size of St. John, as well as that of economics, a steam plant is desirable and in fact in your case absolutely necessary.

The capital cost of this steam plant is found to be \$429,000, the cost of equipment being obtained for this purpose from the makers of boilers and turbine plants. The operating costs are shown under two heads:

(1) A plant operating at full peak capacity with 30% load factor, \$169,000.

(2) Not operating but used as a standby only in case of trouble, \$38,900.

From this it will be seen that the additional standby cost per kilowatt-hour based on the present requirements of the city both for light and power and street lights, including fixed charges of \$42,900, is 1.64 cent per kilowatt-hour, and this must be added to the normal costs of distribution.

Cost of Distribution and Standby

In calculating the operating and fixed charges on the distributing system, advantage has been taken of the offer of the New Brunswick Electric Power Commission to reduce their rate for the first four years from 1.2 cent to 0.8 cent per kilowatt-hour, the city taking and paying for a minimum of 10,000,000 kilowatt-hours.

The cost per kilowatt-hour from these operating and fixed charges works out at 5.98 cents, this cost being obtained with the sale at customers' meters of the 4,200,000 kilowatt-hours shown by the meter records of the company for light and power sold, to which must be added the standby charge of 1.64 cents making a total of 7.62 cents.

Development Period

All of the above it will be noted is on the basis of a rate from the power commission of 0.8 cents on the supposition that the distributing plant when completed will be immediately loaded unopposed with the present customers of the company, and provides nothing for the growing years which will actually exist when business will be unremunerative, nor does it consider the increased price payable to the commission for power thereafter.

The commission under date of January 6 makes certain concessions from the original price of 1.2 cents, which in effect amounts to the remission of the sinking fund, replacement and renewals, and rental, during the three first years to be thereafter repaid except lapsed renewal funds after the business is established.

Mr. Ross estimates a loss on operation during the first four years of \$325,381 which compounded at 6% for three years amounts to \$367,000. This with interest and sinking fund imposes on the undertaking a yearly obligation of \$27,-

526. The total cost of power for the fifth year and after is thus estimated to be 7.99 cents per k.w.h.

Comparison of Light and Power Costs

A great deal of discussion has centered around the question of why the costs for light and power in the city of St. John should be so much greater than in certain municipalities in Ontario. It must be remembered that for this service the cost is pretty nearly a fixed one per customer no matter what power is taken so that when reduced to a kilowatt-hour basis the resulting figures of cost per kilowatt-hour depends on the consumption.

The consumption per customer in St. John is very much lower than in the four Ontario cities mentioned above, and the figures to follow indicate what would occur to costs in St. John were they on the same basis of consumption as in the four cities in question. If such were the case the costs would be as follows:

St. John — 345 k.w.h. per customer per year	5.07c.
Brantford — 500 k.w.h. per customer per year....	3.50c.
Hamilton — 600 k.w.h. per customer per year	2.90c.
London — 650 k.w.h. per customer per year	2.70c.
Windsor — 500 k.w.h. per customer per year	3.50c.

Comparison With Niagara

There has been much loose talk about the cost of power at Niagara and at St. John, and the statement has been made that if the power were given for nothing, the reduction in cost of light and power would be small—the latter statement being true only on the assumption that the consumption remains as at present.

At Niagara, the cost of generated power is \$12.00 per kilowatt-year, which is available to the purchaser for 8,760 hours, the average cost therefore being per kilowatt-hour 0.137 cent; the cost at St. John being 1.2 cents, is nine times as great. Figuring it in another way which comes to the same thing, the Musquash claims an output delivered at St. John of 21,000,000 k.w.h. This divided by 8,760 hours gives a total kilowatt capacity operated every hour in the year as 2,400 kilowatts. The base cost as per commission's figures being \$255,000.00 per year; the cost per kilowatt-year is therefore \$255,000.00 divided by 2,400 = \$106.00, as compared with \$12.00 at Niagara per kilowatt-year and the ratio is again of 1 to 9.

The situation at St. John it is emphasized again is governed by the small use that is made of the capital invested in plant. If the rates at Niagara were available at St. John, a large motor load could be obtained and the equipment provided used to its utmost capacity.

The city of St. John is in the same position as a railway with its right-of-way, tracks, stations, staff, etc. If the traffic is only one train per day the capital and fixed charges per train will be twice what they would be if there were two trains per day. In the case of light and power in St. John the bulk of the charges are fixed.

The distribution plant allowed for St. John must have a capacity sufficient for the peak load even if this only exists for one hour a night, whereas the same equipment would handle several times the amount of power distributed to motors at non-peak hours. Your power rates therefore, while they do not greatly affect the cost of electric power directly, do affect the general situation by which if motor loads could be got (which can only be done by a low rate for purchase power) the capital charges now entirely debited to light and small power would be divided in some proportion to use between customers for light and small power and manufacturing companies using large motors with long-hour consumption.

Reply of Commission

Following the publication of the Ross report, C. O. Foss, chief engineer of the New Brunswick Electric Power Commission, issued a statement in rebuttal, of which the more important portions are reproduced below. In this statement it is said that certain erroneous assumptions made in the Ross report have resulted in the estimate of power therein made being some 20% too low. Exception

is taken to the report more particularly in the matters of the estimate of power at the Musquash and the necessity for a steam standby.

According to the statement of Mr. Foss, Mr. Ross takes the lowest run-off records as gauged by the Dominion Water Power Branch, makes an error in the amount of head, in the efficiency factor of the generating unit, and guessing at the area of the drainage area computes the available power at 17,000,000 k.w.h. in the driest year on record.

In Table 1 of the Ross report it is stated that the static head on the east branch is 95 ft. and on the west branch 117 ft., or an average of 102 ft., whereas the average between 95 and 117 is 106. With this head of 102 ft. with a generator, efficiency of 90% and a wheel efficiency of 80%, "which seems fair when considering the fact that on the St. John demands the load factor of the operating machines will be for many hours 33% or less," the number of cubic feet of water at the wheels necessary to generate one k.w.h. is stated in the Ross report as 579 cu. ft. The static head, states Mr. Foss, is the difference in elevation between tail water and head water and could not in any case be used directly to compute power. The actual working head is less than the static head by the percentage of loss due to friction in racks, gates, pipes, etc. In this case, however, the Ross report quoted the figures of net working head supplied by the commission and erroneously called it static.

The generators have efficiencies guaranteed as follows: Full load 95%, three-quarter load 94.2%, one-half load 92.5%. They have been tested before shipment, under the inspection of the commission's engineers, and have exceeded their guarantee. The turbines have efficiencies guaranteed as follows: Full load 82.5%, three-quarter load 87%, one-half load 82%. Mr. Ross assumes that all three units will operate continuously and a great deal of the time below one-third load. The commission proposes to operate only one unit, or two units, or three units according to the load demand. This will enable it to operate no machine below three-quarter load except for brief periods and the overall efficiency will be 87% of 94.2% or about 82%. The commission estimates the power on 80% efficiency. The following shows how the engineers of the commission compute the available power:

The water powers branch of the Department of the Interior have gauged the water on the Lepreau, and have published complete daily reports of the rate of flow of this stream covering the period from April, 1916, to September 30, 1920. They have supplied the commission with the results from October 1, 1920, to September 30, 1921. From the figures for Lepreau the run-off of the Musquash streams can be very accurately estimated in the same proportion as the respective drainage areas: estimated from existing maps at ninety square miles for the Lepreau and seventy square miles for each branch of the Musquash. So that if the mean rate of flow of Lepreau for one year is 360 cu. ft. per second, the rate for each branch of the Musquash would be 280 cu. ft. per second for that same period. For the climatic year, October 1, 1920, to September 30, 1921, the mean discharge for the Lepreau was found to be 247 cu. ft. per second. For this same period a gauging station was maintained by the water powers branch on the west branch of the Musquash river and the actual mean run-off obtained was 190 cu. ft. per second. Seven-ninths of the measured mean flow of the Lepreau for this period is 192 cu. ft. per second, proving beyond doubt the reliability of the basis of comparison between the two streams.

On this basis the rate of run-off for each branch of the Musquash for three years is as follows:

1917-1918—317 cu. ft. per second
1918-1919—232 cu. ft. per second.
1919-1920—246 cu. ft. per second,

or for the whole period a mean flow of 265 cu. ft. per second for each branch. In estimating the available power a rate of 180 cu. ft. per second for each stream has been adopted.

The net working head at full load on the east branch after allowing for pipe line losses and tidal effect is 95 ft., and on the west 117 ft. Assuming 80% efficiency of gener-

ation, the west branch will develop 1,914 continuous h.p. and the east branch 1,550 continuous h.p., or the two combined will develop 3,464 h.p. throughout every second of the year, or at the rate of 2,585 kilowatts throughout the year. This equals over 22,850,000 k.w.h. per year at the generating station, from which it is estimated that 21,000,000 k.w.h. can be delivered at St. John after allowing for all transmission losses.

The apparent 20% discrepancy between the estimate of the commission's engineers and Mr. Ross is accounted for as follows:

Four per cent. due to error in averaging head.

Eleven per cent. due to low efficiency factor used by Mr. Ross, evidently because he had not familiarized himself with the layout of the plant.

Two per cent. excessive estimate of transmission losses.

Three per cent. to proportioning rainfall records and run-off between various years. Total, 20%.

Mr. Foss criticizes the Ross report with respect to the calculation of power from precipitation records and run-off estimates. He regards Mr. Ross as expecting the same percentage of run-off as obtains in streams through drainage areas that have a different soil formation, different slopes, different vegetable growth, and under various conditions of humidity. The nearest precipitation records are those of St. John over thirty miles from some points on the drainage area.

Referring to Table No. 3, Mr. Foss points out that in 1920 almost 50% more rainfall is recorded at Fredericton than at the Fredericton Experimental Farm, about four miles below Fredericton. On an average 17% more fell in Fredericton than at the Experimental Station. If rainfall varies from 17% to 50% over a distance of four miles in the level interior how much variation, asks Mr. Foss, might be possible between the gauging station on Douglass Avenue, St. John, and parts of the Musquash drainage area thirty-five miles away? It is less accurate to estimate run-off on these rivers from precipitation measured at St. John than from daily records of the actual run-off in the stream measured over a period of four years.

Mr. Foss disagrees with the Ross report as to the necessity of a steam standby plant. It is assumed that the Ross report comprehends a completely equipped steam electric generating plant, ready to be placed in operation at a moment's notice, with 40% of a full operating staff always on hand so that in case of breakdown to the hydro plant a partial supply of electricity would be available for at least the essential domestic and public services. If the chances of complete temporary breakdowns can be shown to warrant such a plant it would be an insurance and a costly insurance. No engineer after inspecting the Musquash layout would anticipate any ice trouble. The dual reliability of the Musquash, in reality the separate developments of two streams, has been repeatedly pointed out by engineers and the chance of any complete breakdown shown to be a minimum, certainly not to justify insurance to the amount of \$81,800 a year.

The Ross report states that as St. John will be depending upon two small streams with stored water a steam plant will be advisable. It is much better, in the view of the commission, to depend upon streams with storage than upon streams without, whether that storage be large natural lakes or lakes increased in capacity by the erection of dams. In fact in this country no continuous water power would be possible without storage. The Ontario Hydro-Electric Power Commission have in at least one case replaced a steam auxiliary by the erection of dams to provide additional water during dry periods. That is exactly what is being done at Musquash and will be done until the last storage site is used.

Rebuttal by Consulting Engineers

An exhaustive report in criticism of that of R. A. Ross & Co. has been made by C. H. and P. H. Mitchell, consulting engineers to the New Brunswick Electric Power Commission. This report supports the view of the chief engineer of the commission that sufficient water is available for the

generation of power to deliver 21,000,000 k.w.h. at St. John, and that a steam standby plant is not necessary as an auxiliary to the hydro-electric plant. The consulting engineers declare that the rates to consumers under the proposed plan can be made attractively low and such as to bear comparison with the rates obtaining in the Hydro-Electric Power System of Ontario.

Analysis by Herbert Phillips

In a series of addresses and in letters to the St. John Daily Telegraph, Herbert Phillips, managing director of the St. John Contracting & Building Co., Ltd., presented arguments to show that current for light and power taken together should cost consumers only 3.5 cents per k.w.h. after the fourth year, as compared with 7.99 cents arrived at by Mr. Ross. At present the average light customer pays about 12 cents per k.w.h., and the average power user about 6 cents per k.w.h. Mr. Phillips supports the view that there is adequate power at the Musquash and that no steam standby plant is needed.

Engineer's Library

MINERAL LAND SURVEYING

Reviewed by
E. W. Banting

Assistant Professor of Surveying, University of Toronto.

MINERAL LAND SURVEYING—By James Underhill, Ph.D., Mining Engineer, U. S. Mineral Surveyor for Colorado. Third Edition, Revised and Enlarged. New York: John Wiley & Sons, Inc. Cloth; 4¼ by 7 in.; pp. 237; illustrated; \$3.50 postpaid (21s. net).

This book might be of interest to provincial surveyors in Canada who are engaged in the survey of mineral claims, in so far as the methods followed in Colorado and the Western States would be of interest in comparison with our own methods.

The first two chapters deal with the methods used in obtaining the bearing of a course of a survey, first by the direct sun observation, and secondly with solar attachments. The most satisfactory way of obtaining the bearing of a course of a survey by Canadian surveyors would be by an observation on Polaris using astronomical field tables provided, on request, by the Surveyor General's Office at Ottawa. These tables are adapted for any time or place in Canada.

Chapters dealing with location surveys, patent surveys, patent field notes, land office records, and examination for commission as United States Mineral Land Surveyors complete the book. Examples of problems are given with their solution.

LAND DRAINAGE by W. L. Powers and T. A. H. Teeter. Published by John Wiley & Sons, Inc., New York. 270 pages; 5½ by 8¼ in.; 106 illustrations; cloth; \$2.75 postpaid.

BUILDING CONTRACTS, the Principles and Practice of their Administration, by Edwin J. Evans. Published by Chapman & Hall, Ltd., London. 304 pp.; 5¼ by 8¼ in.; cloth; price, \$2.50.

HYDRAULICS OF PIPE LINES by W. F. Durand, Ph.D., Professor of Mechanical Engineering, Stanford University, California. Published by the D. Van Nostrand Co., New York, 271 pp.; 134 illustrations; 5½ by 8¼ in.; cloth; \$4.50.

SEWERAGE AND SEWAGE TREATMENT by H. E. Babbitt, Assistant Professor of municipal and sanitary engineering, University of Illinois. Published by John

Wiley & Sons, Inc., New York. 531 pages; 6 by 9 in.; 186 figures; cloth; \$5 postpaid.

MATHEMATICS FOR ENGINEERS—Part 1, including elementary and higher algebra, mensuration and graphs, and plane trigonometry. By W. N. Rose, B.Sc. Published by Chapman & Hall, Ltd., London. Third edition; 54 pp.; illustrated; 5½ by 8¼ in.; cloth; \$2.75 postpaid.

MODERN TUNNELLING by David W. Brunton and John A. Davis. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Ltd., London. Second edition, revised and enlarged, with new chapters on Railroad Tunnelling by J. Vipond Davies. 612 pp.; 6 by 9 ins.; 119 illustrations; cloth; \$6.50 postpaid.

ROAD MAKING MACHINERY—New Catalogue issued by Stroud & Co., Omaha, Neb.; 24 pages and cover; 7½ by 10½ in.; well illustrated; describing elevating graders, road maintainers, wheel scrapers, dump carts, truck bodies, road plows, dump wagons, blade graders, drag scrapers, bulldozers, snowplows, road drags, etc.

When the new pump at the Atwater Avenue station is completed, 30,000,000 gallons per day will be added to the water supply of the city of Montreal, giving a total capacity of 105,000,000 gallons per day from the different low-level stations. Three more pumps of 30,000,000 gallons capacity each will be installed at the low-level station, while a smaller pump of 15,000,000 will be removed to the high-level reservoir at McTavish street. The city's total pressure from the low-level will then be 180,000,000 gallons.

Letter to the Editor

HYDRATED LIME IN CONCRETE MIXTURES

Sir—1 notice in your issue of January 3, 1922, an article by Mr. Shertzer describing the advantages of using hydrated lime in concrete mixtures. In this he makes the following statement:

"Hydrated lime is the most efficient water-tightening medium available. The statement that it is the most efficient medium, has been made by the United States Bureau of Standards as the result of an exhaustive series of tests in which all of the available media were experimented with."

Mr. Shertzer, I believe, refers to a statement made in Technologic Paper No. 3 published in 1911, the title of which is "Tests of the Absorptive and Permeable Properties of Portland Cement Mortars and Concretes together with Tests of Damp-Proofing and Waterproofing Compounds and Materials," and occurs at the bottom of page 59. It refers to hydrated lime and reads as follows: "This is the most efficient medium employed and resulted in an almost impermeable mortar at the two-week test. Its value is probably due to its void-filling properties and the same results could be expected from any other finely ground inert material, such as sand, clay, etc."

It is not my purpose to argue the merits of hydrated lime but it seems to me in fairness to your readers who would naturally place great confidence in an opinion of the Beaura of Standards that they be aware of the use which has been made of this statement of the Bureau. When the full circumstances are known it is almost valueless as supporting evidence of the usefulness of hydrated lime in concrete and Mr. Shertzer's reference to it is misleading.

Yours truly,

RODERICK B. YOUNG,

Senior Assistant Laboratory Engineer,
Hydro-Electric Power Commission of Ontario.
Toronto, Ont., March 24, 1922.

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UNCERTAINTIES RESPECTING WIND BRACING OF BUILDINGS

BUILDING codes, by reason of the necessity for simplicity and definiteness, make certain provisions with respect to the consideration of wind stresses in buildings that close analysis would perhaps not bear out closely. For example, it is stated in some codes that in buildings under one hundred feet in height the wind pressure may be disregarded, provided the height does not exceed four times the average width of the base. In others, these figures are replaced by the ten stories and three times the width of the base respectively. It is also occasionally provided that if the width of a building is at least two-thirds of the height, wind bracing may be omitted for buildings of any height. Just how closely these arbitrary assumptions represent the actual conditions it would be interesting to know.

Another matter of doubt is with respect to the effectiveness of exterior walls, partitions and riveted connections in resisting wind distortion. It is apparent that the efficacy of the walls would much depend upon the number and size of windows therein and that likewise the performance of the partitions would depend upon the openings through them. While each building is of necessity a special case, it would be of value to structural engineers if the efficiency of walls, partitions and connections could be stated in average cases. One instance of this being done is in the well-known monograph by Cyrus A. Melick on Stresses in Tall Buildings, wherein it is noted that the deflection of a seventeen-storey building is reduced by the walls, partitions and connections by only 40%. It would be of interest to know if in any characteristic cases the proportioning of

positive steel bracing members should be made on a basis of about 60% of the wind pressure, as indicated by Dr. Melick in the special case cited.

The extreme laboriousness of all exact solutions of wind stresses in tall buildings has made it necessary for purposes of practical design to use approximate methods. The fundamental assumptions lying back of these methods differ to a material extent on such matters, for example, as the distribution of shear across the columns in a given storey. While there are a number of comparatively simple methods that appear to give satisfactory results in practice, it is by no means certain that the best approximate method has yet been devised. There is in this, as in the matter of the effectiveness of the incidental bracing, a promising field for the investigator who has the time and facility at his command to undertake a careful enquiry into the whole problem of stresses in tall buildings.

MOTOR TRANSPORT ON THE INCREASE

PUBLICATION of the registration statistics for motor vehicles during the year 1921 shows that their use is still increasing at a rapid rate. In Ontario, there were registered during the year 1921, 200,900, as against 172,065 for the year 1920, or an increase of 16%. In Canada, the registrations for these two years were 460,674 and 402,929, respectively, or an increase during the year of 14%. For the United States, these numbers are respectively 10,325,000 and 9,211,295, showing an increase over the year 1920 of 12%. These figures are somewhat remarkable in view of the fact that many persons have predicted a falling off of the use of passenger cars at any rate. It would appear that such forecasts were ill-founded.

Astounding increase of motor transport is apparent on examination of the statistics for the past six years, 1915 to 1921. These show that the Ontario registration for all motor vehicles increased 374%, while for Canada the increase was 426%, and for the United States 322%. An important part of this is due to the use of motor trucks which is growing at a very rapid rate, approximately the same as that for motor cars except that the curve lags about eight years behind that for passenger cars.

In view of these facts, it appears that the problem of the highway engineer with respect to motor traffic is as much in the future as in the past.

OBITUARIES

IGNACE BILODEAU, a well known contractor of Quebec, died in that city on March 27, aged 81.

JOHN F. MacFARLAND, assistant superintendent of the overland department of the Ontario Hydro-Electric Commission, died last week.

CHRISTOPHER FOLEY, contractor, died in Vancouver, B.C., on March 22. Mr. Foley was born in Ontario 78 years ago and had lived in British Columbia 33 years.

J. WILSON GRAY, a well-known architect, died at his home in Toronto on March 28. Mr. Gray was born in Edinburgh, but had been in business in Toronto for 37 years, during which time he designed many public buildings.

PERSONALS

MARTIN MIKEL, of Kitchener, Ont., has been appointed road superintendent.

J. E. BANWELL, of Windsor, Ont., has been elected vice-president of the Ontario Municipal Electrical Association.

FRED C. BELL, engineer of Elgin County, has returned to St. Thomas, Ont., after a month's vacation in the South.

R. FRIZZEL, mining engineer, has returned to Edmonton, from a trip to the Arctic. Mr. Frizzel went north to inspect claims on behalf of an American syndicate who control mining properties in the Copper Mine River District.

A. F. A. COYNE, consulting engineer of Toronto, has been appointed director of instruction of the geology branch of the Petroleum Extension University of Port Wayne, Indiana. Mr. Coyne has spent a number of years investigating the possibilities of oil in Western Canada. He has lectured, among other places, at the Imperial College of Science and Technology, London, England.

HUBERT G. BROWN, who was recently appointed manager of the export department, British Empire Steel Corporation Ltd., was born in Nova Scotia, April 16, 1880, and educated in Amherst and Truro. His first position was



with the New York, New Haven & Hartford Railroad, in the mechanical engineering department, but he returned to Canada to enlist for service in the Boer War. Upon his return from Africa, Mr. Brown was in the engineering department of the Intercolonial Railway at Moncton for a short time, but soon rejoined the N.Y., N.H. & H. Railroad, and subsequently took a special course in mechanical engineering at Boston Technical College. His experiences abroad during the war convinced Mr. Brown

that there was a future in the export business in mechanical lines, and after he had finished his studies at Boston "Tech," he resigned from the railroad and entered the railway supply and export business in New York City. Later he joined the Pullman Company as manager for South America, with headquarters at Buenos Aires, and held this position for eight years, returning to the United States in the fall of 1919 to re-enter the export business as general agent for the Pullman Co., from which concern he resigned in December, 1921, in order to join the British Empire Steel Corporation.

CANADA WANTS WORLD CONGRESS ON GOOD ROADS

HAVING recently become a member of the International Association of Road Congresses, the Canadian Good Roads Association, through its executive, will exert a determined effort to secure for some Canadian city the fifth congress of that distinguished association, which is due to be held in 1925. Since the inception of the International Congress in 1909 only three conferences have been held owing to the intervention of the war. The first was held in Paris in 1909 and the second and third congresses were held before the war intervened and necessitated suspension of the work. It is only recently that the International Association has been able to resume its activities and to lay its plans for the fourth congress, which will be held in the Spanish city of Seville, probably in 1923. The date has not yet been fixed definitely because there remains much preliminary work to be done, but it is probable that it will be held within a year.

Meanwhile, however, the executive of the International

Association will hold a meeting, probably at the headquarters in Paris, in May or June of 1922, and it is to this meeting that any invitation for the succeeding or fifth congress should be addressed.

The Canadian Association proposes in the meantime to devote a considerable portion of its energies to placing itself and the Dominion of Canada in a position which will permit of an official invitation being extended for the fifth congress which, it is expected, will be held either in 1924 or 1925. The first step will be to convince the Canadian Government of the desirability of enrolling Canada as an "official adherent" of the International Association, a procedure which involves the granting of an annual subsidy of at least 1,000 francs, which entitles Canada to send one delegate to the congress, with a delegate for each additional 1,000 francs.

To bring the congress to Canada would necessarily mean also the assurance of a fund adequate for the providing of a suitable meeting place, for the general expenses attached to such a gathering, and for the suitable entertainment of the eminent engineers, Government officials and prominent laymen interested in good roads who would come as delegates from thirty countries, representing virtually the whole of allied and neutral civilization, none of the late enemy countries being at present members of the International Association.

It is considered that Canada has an exceptionally good opportunity to get the fifth congress. There exists among the delegates of the countries, who are members of the international association, a desire to visit the American continent and see something of the good roads progress that has been made here. Several matters, among which is the necessity for Congressional appropriations, preclude an invitation from the United States, so that Canada has the American field of favor to herself.

The governments of the following thirty countries have already given adhesion to the international association: Algeria, Argentina, Belgium, Chili, China, Cuba, Czechoslovakia, Denmark, France, Great Britain, Greece, Holland, British India, Dutch Indies, Italy, Japan, Luxembourg, Mexico, Monaco, Norway, Poland, Portugal, Roumania, Spain, Siam, Serbia, and Jugo-Slavia, Sweden, Switzerland, Tunis and Uruguay. The two latest of these subscribing nations are Czechoslovakia and China. Canada, it would seem, should not lag behind.

The executive of the Canadian Good Roads Association has already deputed several of its members as a delegation to wait upon the new Dominion Government to lay the matter before it and urge the necessary action to bring the fifth congress to Canada.

ONTARIO COUNTY ROAD MEN MEET

ROAD foremen, pathmasters and the Reeves and Councilors of the various municipalities in Ontario county met at Port Perry, Ont., on March 22 for a conference on road building. Sixty delegates were present. D. J. Kean, county road superintendent, presided over the gathering. Different types of road construction were discussed and local road conditions thoroughly investigated. The chief speaker was John MacVickar of the Provincial Department of Highways. Moving pictures were shown illustrating the gradual steps in the history of road building both in this country and in England.

Applications will be received until noon, April 6, by V. W. McFarlane, secretary-treasurer, Stonewall, Man., for the position of civil engineer for the municipality of Rockwood, Man. Duties are to commence May 1 unless by mutual agreement an earlier date can be set. Applicants are to state qualifications, experience and salary expected. All applications are to be in sealed envelopes marked, "Application for Engineer."

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Stratford, Ont., construction of concrete base and combined concrete curb and gutter	Apr. 8	Mar. 28
Quebec, Province of, construction of waterbound macadam	Apr. 5	Mar. 21
Belwood, Ont., erection of steel bridge superstructure	Apr. 5	Mar. 21
Guelph, Ont., erection of Memorial Hall	Apr. 5	Mar. 28
Halifax, N.S., construction of roads	Apr. 6	Mar. 28
Toronto, Ont., bituminous concrete pavement	Apr. 7	Mar. 28
Fort Frances, Ont., alterations and additions to Public School	Apr. 7	Mar. 28
Halifax, N.S., construction of roads	Apr. 8	Mar. 28
Halifax, N.S., construction of roads	Apr. 10	Mar. 28
Chippawa, Ont., construction of concrete intake structure and ship channel in Niagara River	Apr. 10	Mar. 14
Ontario, Province of, widening and deepening the channel of the Welland River and a portion of the Queenston-Chippawa power canal	Apr. 10	Mar. 14
St. Catharines, Ont., construction of Collegiate Institute and Vocational School	Apr. 11	Mar. 21
Leamington, Ont., construction of pavement	Apr. 15	Mar. 28
Victoria, B.C., fabrication and erection of part of superstructure of Johnson St. bridge	Apr. 17	Mar. 21

BRIDGES, ROADS AND STREETS

Aurora, Ont.—Council has awarded contract for paving Wellington St. to the Warren Bituminous Paving Co., Toronto. Engineer, E. A. James, 36 Toronto St., Toronto.

Banff, Alta.—Dominion Government Department of Public Works plans to proceed at an early date with the completion of the Banff-Windermere Road.

Barton Tp., Ont.—Township Council plans construction of a sidewalk on the east side of Wentworth St., from the end of the present walk to Queensdale Ave. Brucevale Ave. will be re-metalled from Wellington to James St. Clerk, A. G. E. Bryant, Hamilton.

Birch Cliff, Ont.—Searboro Township Council plans to construct a concrete sidewalk on the north side of Kingston road, from Archibald Ave. to the city limits. Also a concrete sidewalk on the north side of Danforth Ave., from Victoria Park Ave. to Danforth road. Clerk, W. D. Annis, Searboro.

Brantford, Ont.—Tenders addressed to Ald. Wm. H. Ballantyne, Chairman, Board of Works, will be received until 12 o'clock noon, Thursday, April 13, for the city's supply of road oil, asphalt, Portland cement and castings for 1922. City Engineer, F. P. Adams.

Bridgeburg, Ont.—William German, M.P., for Welland County, of the firm of German & Brooks, announced that he will immediately introduce a bill at Ottawa in connection with the proposed bridge to be built over the Niagara by private capital.

British Columbia, Province of.—Tenders endorsed "Tender for Construction Trans-Provincial, Project 23, Sections G. & K." will be received by the Hon. Minister of Public Works, Victoria, until noon, Monday, April 10, for the construction of 19 miles of the above road. Plans and specifications may be seen at the District Engineer's Office, Court House, Vancouver; at the Court House, Rossland; at the office of the District Engineer, Penticton; and at the office of P. Philip, Public Works Engineer, Department of Public Works, Victoria.

Burlington, Ont.—Town Council decided to have plans and specifications prepared for a concrete road on Brant St., from Water St. to Caroline St., and an 18-ft. strip from Caroline St. to the middle road.

Chatham, Ont.—Kent County Council's road program for this year calls for an expenditure of \$612,150.

Chatham, Ont.—The city will probably pave this year Cornhill St., Water St., Ursuline Ave., Lowe St. Sidewalks are contemplated on Third St., Richmond St., Gladstone Ave., and sewers on Poplar St. and Park Ave. Considerable sewer work was carried on during the winter under provincial and federal aid to relieve unemployment. City Engineer C. H. R. Fuller.

Chatham, Ont.—Kent County Council recently heard a deputation from the City of Chatham which sought county co-operation in a plan to have the provincial highway scheme for the current year extended. The particular request was that the Government be urged to complete the pavement of the Longwoods Road from Chatham as far as Louisville, the road to be gravelled from that point to Kent Bridge.

Cornwall, Ont.—Tenders for the grading and construction of about half a mile of pavement on Pitt St., will be received by J. G. Harkness, town clerk, until 12 o'clock noon, Saturday, April 8.

Ford City, Ont.—Town Council endorsed the request of the Suburban Area Commission that Pillette road be paved within three years, from the Grand Trunk tracks to Tecumseh road. Estimated cost, \$16,270.

Halifax, N.S.—Tenders, addressed to the Provincial Highways Board, will be received until noon, April 12, 15 and 18 for highway construction. (See official adv.)

Halifax, N.S.—Tenders, addressed to the Provincial Highways Board, Halifax, will be received until noon, April 19, for surfacing with gravel ten miles of the Truro-Glace Bay Road.

Hamilton, Ont.—The widening of Catharine St., to provide a better site for the new building of the local Hydro Commission, was approved by the City Council, but was referred back to the Board of Control for further consideration. Estimated total cost, \$42,078.43.

Kingsville, Ont.—Alternative tenders will be received by W. G. Long, town clerk, until 12 o'clock noon, Monday, April 17, for labor and materials necessary for the construction of reinforced concrete, base and stone filled asphalt, or base and bitulithic asphalt, together with necessary excavating, curbing, etc. Approximate area, 40,000 sq. yds. Plans and specifications are on file at the town clerk's office, and at the office of Code & Code, civil engineers, Windsor.

Kitchener, Ont.—Tenders will be received until noon, Monday, April 10, by Samuel Cassel, Clerk of Waterloo

County, Court House, Kitchener, for the following: Approximately 18,773 sq. yds. concrete pavement in Township of Woolwich; approximately 4,689 sq. yds. concrete pavement between Preston and Hespeler; approximately 622 sq. yds. concrete pavement in village of West Montrose; approximately 1,778 sq. yds. concrete pavement north of Town of Waterloo; approximately 1,030 sq. yds. concrete pavement in the Village of Bridgeport; and retaining walls at Bridgeport. Specifications may be seen at the County Clerk's office. Further information from L. S. Lichty, County Road Supt., Wellesley, Ont.

London, Ont.—Middlesex County Council plans to spend \$200,000 on roads this year. Engineer, Charles Talbot, London.

London, Ont.—Work will be proceeded with immediately by the G.T.R. on new approaches and abutments at Hutton's bridge in London Township.

Minotia, Man.—Municipality has sold a bond issue amounting to \$86,000 for road purposes. Clerk, W. E. Warren.

Montreal, Que.—Executive committee of City Council submitted a report to Council asking for approval of the plans for rebuilding the Ontario St. subway at a cost of \$250,000.

Niagara Falls, Ont.—The Niagara Bridge Co., owners of the cantilever bridge here which crosses the Niagara River near the lower bridge, announced that a new bridge will be built this year.

Niagara Falls, Ont.—Hydro-Electric Power Commission of Ontario are reported to have let contract for erection of bridge across Lundy's Lane to the Hamilton Bridge Co., of Hamilton. It is said the bridge will be of steel construction and is estimated to cost \$60,000.

Ottawa, Ont.—Carelton County Council passed by-law providing for the widening of the Metcalfe road.

Ottawa, Ont.—Tenders will be received at the office of the Suburban Roads Commission until 11:30 a.m., Thursday, April 6, for the construction of approximately 3½ miles of asphaltic concrete surface. Plans and specifications may be seen at the office of the Commission, 26 Wellington St.

Ottawa, Ont.—Carelton County Council is endeavoring to have the Dominion Government take over 25 miles of roads leading into Ottawa, including the following: Richmond, Montreal, Russel, Metcalfe and Bowesville roads, Ottawa-Prescott highway, Pembroke-Ottawa highway, and the Kingston-Ottawa highway.

Owen Sound, Ont.—Suburban Area Commission plans to repair St. Vincent road and construct the North Gravel road further westward this year. Address C. H. Thompson.

Peterboro, Ont.—Concrete paving is to be laid on the principal street this spring. City Engineer, R. H. Parsons.

Peterboro, Ont.—John McVicar, district engineer of municipal roads under the Department of Highways, has authorized the local suburban area commission to widen to the prescribed width of 66 ft. any roadways that are now less than that width.

Quebec, Province of.—Iron bridges costing a total sum of \$370,000, are under construction at the following places by the Department of Public Works: East Angus, Drummondville, St. Stanislas and St. Alexis. A total sum of \$600,000 has been voted by the Legislature for the building of bridges at Perrot Island.

Sandwich, Ont.—S. P. West, of Sandwich, was awarded contract at \$11,986.50 for paving Tournier and Baby Streets, and for paving Chippewa St. for \$20,351.62; contract for paving Partington Ave. was awarded to Pettypiece's, Ltd., of Amherstburg, at \$15,447.20; and for laying sidewalks on several streets to L. J. Ryan, of Windsor, for \$3,965.68.

Sherbrooke, Que.—The following streets will be paved next summer: Alexander, between Aberdeen and King St. West; Belvidere, between Frontenac and Drummond Streets; Bowen, between King St. East and Council St.; Brooks, between Aberdeen and Ball Streets; Frontenac, between Marquette and Belvidere Streets; King West, between

Belvidere St. and the city limits; Montreal, between Duferin St. and Queen St. City Engineer, Thomas Tremblay.

Stratford, Ont.—Tenders will be received until 12 o'clock noon, Saturday, April 8, by A. B. Manson, city engineer, for the construction of approximately 32,000 sq. yds. of concrete base for pavement and approximately 22,000 ft. of combined concrete curb and gutter.

Terrebonne, Que.—Provincial Department of Public Works will construct a bridge across the Thousand Island River at Montee Filion, provided the municipalities concerned are willing to pay 50% of the cost. Minister of Public Works, Hon. A. Galipeault.

Toronto, Ont.—Toronto and York Roads Commission will spend \$450,000 on county roads this year.

Toronto, Ont.—Works committee decided to have a 46-ft. pavement laid on Parliament St., from Queen to Wellesley St., at a cost of \$153,413.

Toronto, Ont.—Board of Control awarded contract to the Warren Bituminous Paving Co. of Ontario, Ltd., Toronto, for laying a bitulithic pavement on Coleman Ave., at a cost of \$27,095.

Toronto, Ont.—North Toronto Ratepayers' Association appointed a committee consisting of A. O. Thorne, W. E. Ellis and J. Schillinger to take up the matter of having Avenue road widened to 86 ft.

Toronto, Ont.—City Council is considering the question of proceeding at once with the paving of at least one side of Yonge St., which will require the Metropolitan Railway to move its tracks to the centre of the street.

Toronto, Ont.—Works Commissioner Harris informed the civic works committee that the widening of Bloor St., from Lansdowne Ave. to Dundas St., to a width of 86 ft., would cost \$387,000. The officials recommended that the plan be adopted.

Toronto, Ont.—Works Commissioner Harris again recommended to City Council the widening of Bloor St. to a width of 86 ft., from Sherbourne St. to Spadina Ave., and also approved of widening the street from Lansdowne Ave. to Dundas St. Total cost, \$1,878,000.

Toronto, Ont.—City Council intends to construct the following: Asphalt pavements on Fairford Ave., Maughan Crescent and Washaw Ave., at a total cost of \$77,102; concrete pavement on St. Clair Ave., \$35,348; concrete curbs, Fairford Ave., Hemlock Ave. and Maughan Crescent, \$3,366; and concrete sidewalk on Raglan Ave., \$614.

Toronto, Ont.—Toronto & York Roads Commission have awarded contracts for waterbound macadam roads to E. S. Dagg, of Woodbridge; for bituminous macadam roads to the E. A. Jupp Construction Co., Ltd., of Toronto; and for bituminous concrete on concrete to the Constructing & Paving Co., of Toronto. Engineer E. A. James, 57 Adelaide St. East.

Toronto, Ont.—That it would cost \$3,000,000 for the city to build a subway under Yonge St. for street railway tracks, from the lower level opposite Ramsden Park to the C.P.R. subway, south side, and from the C.P.R. subway, north side, to the old belt line railway, is the opinion given by Works Commissioner Harris in a report to the civic works committee.

Toronto, Ont.—Works Commissioner Harris submitted to the Works Committee a report as to the cost of constructing a subway on Yonge St., from Ramsden Park to Mount Pleasant Cemetery. He estimates it would cost approximately \$3,000,000, whereas Ald. Burgess, who suggested it, figured on \$500,000. A detailed examination of the scheme will cost \$25,000. The matter was laid over by the committee for another week.

Toronto, Ont.—Works Committee approved Works Commissioner Harris' list of local improvements to be undertaken this year under the \$3,000,000 limit ordered by the City Council. The list submitted, however, totals \$3,771,452, and include the following large items: Dundas St. extension, \$460,000; Yonge St. pavement, \$689,916; Teraulay St. pavement, College to Bloor, \$240,896; Sunnyside sewers, \$301,000; Lake Shore paving \$200,671.

Toronto, Ont.—Toronto has been asked by the Provincial Department of Highways to assume the liability for 20% of a \$5,000,000 road and bridge building program which will provide adequate highway entrances into the city from the north, east and west. Whether or not the work will be undertaken this year depends on the attitude of the City Council. The program includes a high level bridge over the Humber at Bloor St., another over the Don on Yonge St., and for a subway under the G.T.R. tracks on an easterly extension of the Danforth to the Kingston Road. Hon. F. C. Biggs stated that the Government is ready to let tenders for immediate construction, provided the city would pay 1/5 of the cost.

Vancouver, B.C.—At an expenditure of approximately \$200,000, the Canadian Pacific Railway Co. has taken steps to immediately replace the bridge across the Coquitlam river with a permanent steel and masonry structure. W. D. Grant, 739 Granville St., was the successful tenderer at \$74,000 for the foundation piers and abutments, and the contract for the supply, fabrication and erection of the double-track, through-truss steel span was awarded to the Canadian Bridge Co., Ltd., of Walkerville, Ont. This contract is said to be in excess of \$100,000 for approximately 700 tons of steel plates and heavy girders required in the 200-ft. span.

Victoria, B.C.—Hon. Dr. W. H. Sutherland, minister of public works, plans to have the Ymir Road completed.

Victoria, B.C.—A more aggressive road paving and improvement scheme for the section of the southern part of the Island including Metchosin, Sooke, Happy Valley and Luxton districts, together with more efficient methods of maintenance of the side roads communicating with the main arteries, was urged by a large and representative delegation which waited upon Hon. W. H. Sutherland, minister of public works, recently.

West Hill, Ont.—Construction of the Provincial high-level bridge on the Kingston road here is scheduled to start immediately.

Woodstock, Ont.—G.T.R. have decided to erect a foot-bridge over the Bay St. bridge.

Woodstock, Ont.—Oxford County Council estimates \$160,000 as the amount of money required for construction and maintenance of county roads for 1922, half of which will be for construction and half for repairs. Road Superintendent, William Forbes, Woodstock.

York Tp., Ont.—Contract for grading Goyder Ave. has been let to D. Mackay.

York Tp., Ont.—Township Council decided to widen various roads to 66 ft. Engineer, Frank Barber, Toronto.

York Tp., Ont.—Tenders will be received by Frank Barber, Township Engineer, Toronto, until 10 a.m., Monday, April 17, for the construction of six reinforced concrete culverts. (See official adv.).

WATER, SEWAGE AND REFUSE

Birch Cliff, Ont.—Scarboro Township Council will consider the placing of street lights in the Birch Cliff Heights and Kitchener Park districts, and also at Kennedy road G.T.R. crossing. Clerk, W. D. Annis, Scarboro.

Hamilton, Ont.—Controller Jutten will urge the Board of Control to have the tenders received for the proposed storm overflow sewer returned, and new tenders for the construction of the sewer by means of an open cut instead of the tunnelling method, upon which the present prices are based, called for.

Hamilton, Ont.—Tenders will be received by S. H. Kent, city clerk, addressed to George C. Copley (Mayor), chairman, Board of Control, City Hall, until 5 o'clock p.m., Monday, April 16, for the construction of section No. 3, Western storm overflow sewer. Specifications may be obtained at office of E. R. Gray, City Engineer.

Kitchener, Ont.—City Council instructed City Engineer S. Shupe to prepare plans for the West Ward storm drain.

Kitchener, Ont.—Contract for pump house and pump well for water supply has been awarded by City Council to B. G. Mitchell & Co., Kitchener. The tenders ran from \$15,000 to \$22,000. The following also submitted bids: Dunker Bros., Kitchener; Canadian Engineering & Contracting Co., Hamilton; Taylor Construction Co., Hamilton; H. H. Fernald, Kitchener; and Gilbert S. Wright, Toronto.

Montreal, Que.—For the necessary work in connection with putting into operation at the end of the current year the completed aqueduct, including the new pumping station, the executive committee of the City Council submitted a report to the Council recommending the voting of \$1,250,000.

Montreal, Que.—Considerable sewer construction work is about to be let by contract by the executive committee of the City Council. The lowest tenders received require an outlay of about \$90,000. With one exception, for a small job, the contracting firm of Ovila Filion & Frere submitted the lowest bids.

Pointe au Pic, Que.—Plans of proposed improvements to the water works system have been deposited with the Public Service Commission, Quebec, by A. Lariviere, engineer of the commission.

Quebec, Province of—Legislature passed a bill authorizing the Quebec Streams Commission to construct storage dams or other necessary works in Lakes Ouareau, Archambault and Blanc and in the river Ouareau near St. Agathe, for the purpose of storing their waters and of regulating their flow for the better utilization of the waterpowers to be obtained. The work is to be done by contract. Estimated cost, \$250,000.

Riverside, Ont.—Council instructed the town engineer to make reports on water mains and sidewalks for Menard subdivision and water mains on Riverside Drive. Also water mains on property from the Eau Claire water works to Little River and to Intersection road.

St. John, N.B.—The construction of a trunk sewer to take care of the outfall of service sewers on Lansdowne and Dufferin Avenues, and provide outfall for service sewers when installed on Metcalf St. extension and other areas in that vicinity, is projected.

Toronto, Ont.—Tenders will be received, addressed to C. Alfred Maguire (Mayor), Chairman, Board of Control, City Hall, until noon, Tuesday, April 11, for the laying and jointing of 6-in. water pipes in Nursewood Road. Specifications may be obtained at the office of the Water Main Extension Section, Department of Public Works, Room 320, City Hall. Also for the construction of a sewer in Strathmore Boulevard, from Woodington Ave. to Glehemount Ave. Specifications may be seen at the Works Department, Room 6, City Hall.

Toronto, Ont.—City Council intends to construct a sewer in Small St., at a cost of \$1,770.

Toronto, Ont.—Contracts for the laying and jointing of water pipes in Melrose Ave., Small St., Willard Ave., Woodbine Ave. and Ardagh St., have been let to Ruscica Bros. for a total of \$1,248.76.

Vernon, Ont.—E. A. James, consulting engineer, Toronto, has been engaged to prepare plans for a complete water works system for the village. The system will be of the gravity type and will be installed this year.

Winnipeg, Man.—The Public Utilities Commission decided on \$100,000 as the amount to be expended on sewer construction this year.

Woodstock, Ont.—City Council will be asked to submit a by-law at the next municipal election to authorize the raising of \$38,500 for an inclinator.

LIGHT, HEAT AND POWER

London, Ont.—Work in connection with the Hydro power line for London Township is expected to commence in a few weeks.

Victoria, B.C.—City Council awarded contracts for electrical supplies to the Canadian General Electric Co. amounting to \$4,100, and to Hawkins & Hayward, \$2,360.

Warkworth, Ont.—Village lighting system will likely be changed to a Hydro system.

Winnipeg, Man.—Contract has been awarded to the Winnipeg office of the Northern Electric Co. by the Manitoba Telephone System for Strowger automatic telephone equipment necessary to convert the Fort Rouge exchange to automatic service, the price being \$423,254.

RAILWAYS

Edmonton, Alta.—Edmonton, Dunvegan & B. C. Railway will be extended this year fifteen miles west from Grande Prairie City, present terminus, to a point near Lake Saskatoon, the necessary bill having been put through the Provincial Legislature.

Edmonton, Alta.—Extensions to three of Alberta's northern railways to the extent of 39.5 miles will be made this year, at a cost of \$1,006,000 for actual construction, and a further sum of \$514,456 will be devoted to maintenance, upkeep and equipment, according to an announcement at a recent session of the Legislature. The lines to be extended are the Lacombe and Northwestern Railway, 11.5 miles; Central Canada, 13 miles; and the Edmonton, Dunvegan and British Columbia, 15 miles.

Ford City, Ont.—T. U. Fairlie, railway engineer for the Hydro-Electric Power Commission of Ontario, estimates the cost to Ford City of moving the tracks from the side of Ottawa St. to the middle of the thoroughfare at \$19,040.

London, Ont.—G.T.R. will proceed at an early date with the laying of new steel between London and Sarnia.

Montreal, Que.—President E. W. Beatty of the C.P.R. announces that the directors of the company have authorized expenditures during the present year amounting to \$10,622,137, including \$1,021,700 for replacement and enlargement of permanent structures, \$1,008,200 for additional stations, sheds, etc.; \$1,500,700 for replacement of tracks with heavier sections, \$1,500,000 for a new pier at Vancouver and \$1,454,500 for extensions to Chateau Frontenac, Quebec.

Ottawa, Ont.—A deputation representing Niagara municipalities waited upon the Minister of Railways, Hon. W. C. Kennedy, with a request that the Government should make improvements to the Niagara, St. Catharines and Toronto Electric Railway, which is part of the National System.

St. Thomas, Ont.—Wabash Railway Co. has definitely decided to erect new locomotive repair shops on the local Canadian division. Estimated cost, \$500,000.

Windsor, Ont.—Tenders for the erection of new freight sheds and yards here have been called for by the Canadian Pacific Railway Co. The company will spend approximately \$250,000 on improvements in Windsor.

Winnipeg, Man.—Contract for the relaying of pipe lines at various points in the Manitoba district of the Canadian Pacific Railway has been awarded to the Hurst Engineering & Construction Co., Scott Block, Winnipeg.

Yorkton, Sask.—Local Board of Trade is agitating for the early completion of the 60-mile railway gap between Sturgis and Hudson Bay Junction.

FACTORIES AND LARGE BUILDINGS

Amherst, N.S.—Fire gutted the Lusby-McDonald Block on Crescent Ave., causing a loss of approximately \$30,000.

Annapolis Royal, N.S.—Contract for erection of Memorial Town Hall has been let to Allen & McCaw, of St. John, N.B.

Brantford, Ont.—Board of Education asked the City Council to extend the by-law providing for the construction of a school on Terrace Hill for two years, and in the meantime to pass a by-law providing for the raising of approximately \$80,000 for an addition of 8 rooms to the Collegiate Institute.

Campbellford, Ont.—The erection of a High School is projected. Estimated cost, \$35,000.

Carleton Place, Ont.—The Board of Education is asking the Town Council to submit a by-law for \$110,000, to erect a new High School and convert the former building into a new public school.

Chapleau, Ont.—Contract for erection of school building awarded to Angus & Taylor, Ltd., North Bay, at \$74,666.

Colborne, Ont.—By-law passed authorizing Town Council to provide \$30,000 for erection of High School.

Delhi, Ont.—Village Council contemplates extension of school accommodation, and a by-law to authorize the raising of \$15,000 will shortly be submitted to the ratepayers.

Delia, Alta.—Tenders for the erection of a schoolhouse for Newport School District No. 3,233 will be received until April 20 by John O. McKee, Sec.-Treas., Delia, Alta.

Edmonton, Alta.—Permit issued to Crossland Printing & Publishing Co. for the construction of a printing office near the corner of 102nd Ave. Contractor, H. P. Alexander.

Ford City, Ont.—The erection of an Anglican Church in Englewood Park is projected.

Fort Frances, Ont.—High School Board has authorized its architect to submit plans for a high school building to cost \$60,000.

Fort William, Ont.—Tenders will be received until 12 o'clock noon, Monday, April 17, for the erection of an addition to Ogden Public School. Architect, Harry M. Scott, 200 Cuthbertson Bldg.

Fredericton, N.B.—Tenders for Canoe Factory will be received until 12 o'clock noon, Saturday, April 8. Plans and specifications may be seen at the store of R. Chestnut & Sons, Ltd., Queen St., and any further information may be obtained from W. E. Minue, architect, 220 Aberdeen St.

Galt, Ont.—Plans are being prepared for an addition to the Collegiate Institute.

Galt, Ont.—Work has started on the construction of an addition to the plant of the Riverside Silk Mills.

Galt, Ont.—Contract for construction of addition to factory of the Riverside Silk Mills awarded to Charles McInnes, of Galt.

Galt, Ont.—City Council and Board of Trade endorsed an industrial proposition to establish a tire manufacturing plant here, 200 by 100 ft.

Galt, Ont.—Trustee Board of the Methodist Church decided to erect a new Sunday School building this season, at an approximate cost of \$20,000.

Hamilton, Ont.—Time for receiving tenders for the building of a Masonic Temple, addressed to W. M. Logan, 10 Gore St., Secretary of Towers, Ltd., has been extended to 12 o'clock noon, April 8.

Hastings, Ont.—A free site for the erection of a school has been offered to the town by John Coughlan.

Kentville, N.S.—Erection of an arena is projected.

Kingston, Ont.—The curling rink, the property of Queen's University, was destroyed by fire.

Kitchener, Ont.—Excavation work has started for the new \$30,000 parish hall of St. Peter's Lutheran Church.

London, Ont.—Board of Education plans erection of a four-room addition to Ealing School. Estimated cost, \$45,000.

London, Ont.—A movement is on foot among the various civic organizations to have a new G.T.R. station built here this year.

London, Ont.—Board of Governors of Western University announced that work on the new buildings will be commenced on April 15.

Mimico, Ont.—The sum of \$29,656 will be spent on public schools this year in addition to the erection of a school on Church St. An agitation has begun for the erection of a High School under a joint board of New Toronto and Mimico trustees.

Mimico, Ont.—Separate and bulk tenders will be received until noon, April 8, for all trades required in the construction of a six-roomed school. Plans and specifications may be seen at the office of the architect, Harold R. Watson, 907 Excelsior Life Bldg., Toronto, or at the Mimico Public School Building.

Montreal, Que.—A proposal to erect a public bath on the west side of Amherst street in front of the St. James Market is being made to the executive committee of the city by Ald. Genereux.

Mount Dennis, Ont.—Fire destroyed the plant of the Canadian Nitro Products Co. Loss, \$75,000.

Norwood, Ont.—A Carnegie library is to be erected here.

Oshawa, Ont.—Oshawa Golf Club plan erection of clubhouse at cost of \$10,000.

Oshawa, Ont.—Board of Education decided to spend \$220,000 during the coming summer on school improvements, including the erection of a 12-room school and an S-room school.

Ottawa, Ont.—Fire damaged the building occupied by the Ottawa Typewriter Co., 191 Queen St., to the extent of \$60,000. Owner, H. C. Brennan.

Ottawa, Ont.—Tenders will be called shortly for the re-modeling of St. Matthew's Church. Estimated cost, \$30,000. Architects, Millson & Burgess.

Ottawa, Ont.—Contract for addition to University of Ottawa has been awarded to John Quinlan & Co., of Montreal. Their tender was \$114,000, the lowest of ten submitted.

Ottawa, Ont.—Collegiate Institute Board awarded the following contracts in connection with the erection of Percy St. Collegiate Institute: Plumbing and heating, W. G. Edge, Ltd., \$63,938; lathing and plastering, E. J. Currie, Toronto, \$34,288; marble and tile work, A. K. Mills, \$29,388; roofing, J. D. Sanderson, \$2,619; tinsmithing and sheet metal work, W. G. Edge, Ltd., \$32,900; electric wiring, Marchand Electric Co., \$15,730; painting and glazing, J. B. Dufour, \$21,365.

Peace River, Alta.—Peace River Creamery Co. will build a plant.

Peterborough, Ont.—Board of Education considering erection of addition to Collegiate Institute. Approximate cost, \$150,000.

Port Arthur, Ont.—Following contracts have been awarded for erection of extension to plant of the Provincial Paper Mills, Ltd.: Machinery, Port Arthur Shipbuilding Co., Port Arthur; structural steel, Dominion Bridge Co., Montreal; and for the building to J. C. Trimble, of Toronto. The extension was designed by H. S. Taylor, Ltd., Montreal. Total estimated cost, \$1,500,000.

Preston, Ont.—Methodist Church board plans erection of Sunday School building at a cost of \$20,000.

Preston, Ont.—Contract for erection of Sunday School building for Methodist Church awarded to Albert Coher, of Hespeler. Estimated cost, \$20,000.

Prince Rupert, B.C.—By-law providing for the establishment of a municipal library by the City Council was passed by the ratepayers. City Clerk, E. A. Woods.

Quebec, Que.—Convent of Port Alfred, Chicoutimi County, was destroyed by fire. Loss, \$50,000.

Quebec, Que.—Knights of Columbus plan to construct a new wing to the present building on Grande Allee and to install a swimming pool and gymnasium. Estimated cost, \$60,000.

Regina, Sask.—The Separate School Board is raising \$12,000 for the erection of a school in the north end of the city.

Renfrew, Ont.—Work will start shortly on the erection of a new Collegiate Institute.

Riverside, Ont.—Town Council authorized H. A. Lothian, architect, to prepare plans and specifications for the proposed \$15,000 Town Hall.

St. Anne de Beaupre, Que.—St. Anne's Church, recently destroyed by fire, will be rebuilt.

St. Catharines, Ont.—Fire damaged the plant of the Packard Electric Co. to the extent of \$20,000.

St. John, N.B.—Excavation has started on the site of a new Sunday School building to be erected in connection with the Main Street Baptist Church.

St. John, N.B.—Plans are under way for the erection of a home for the I.O.O.F. for the Maritime Provinces and

Newfoundland. Address C. L. Woods, Truro, N.S., Grand Master.

St. Lambert, Que.—A public assembly hall combined with a fire station, a large annex to the principal school and two new school buildings are to be built by the City Council and School Commissioners at an expenditure of over a quarter of a million dollars. The hall, fire station and new school annex will be built this year, the former at a cost of \$140,000.

St. Mary's, Ont.—W. G. Murray architect, London, is preparing plans for the proposed extensions to the Collegiate Institute.

St. Thomas, Ont.—Erection of a Y.W.C.A. building is projected.

Sandwich, Ont.—Tenders for the construction of Essex County tuberculosis sanatorium will be received until April 10.

Sarnia, Ont.—Citizens decided to form a company capitalized at \$100,000 for the erection of a skating rink costing \$40,000, with an artificial ice refrigerating plant at an additional expenditure of \$30,000.

Stratford, Ont.—Mr. Dodds, of this city, plans the erection of a plant for the manufacture of flour milling machinery and other equipment.

Stratford, Ont.—Tenders will be received by J. M. Riddell, Secretary-Treasurer, Board of Education, until 5 p.m., Monday, April 10, for all trades in connection with the erection of a 4-roomed school. Plans and specifications may be obtained from H. G. Holman, architect, Suite 2, Beacon Building, Stratford.

Sudbury, Ont.—Canada Creosoting Co. plans to erect an addition to its plant. The company may also construct a million dollar plant at Capreol this summer.

Toronto, Ont.—Fire destroyed the warehouse of the Toronto Storage Co., 37 River St. Loss, \$7,500.

Toronto, Ont.—Ratepayers of Lakeview district have been asked to authorize the erection of another school.

Toronto, Ont.—Riverdale ratepayers are urging action by the City Council in establishing an east end library.

Toronto, Ont.—Officials of Greenwood Ave. Presbyterian Church have secured a loan of \$17,000 for the erection of a new building.

Toronto, Ont.—Board of Education is considering the purchase of a site and the erection of an 8-roomed school somewhere south of College St.

Toronto, Ont.—Board of Education will have plans and specifications prepared and call for tenders for a 4-room addition to Manning Ave. School.

Toronto, Ont.—Drawings and specifications are nearly completed for Jarvis Street Collegiate, and tenders will be called this week by the Board of Education.

Toronto, Ont.—Beverly Street Baptist Church members will launch a campaign to raise \$35,000 for extensions to the Sunday School accommodation. Pastor, Rev. E. O. Forde.

Toronto, Ont.—Architect W. H. Moore has been instructed to proceed with the building of the new \$60,000 eight-room Separate School in Moore Park, and four rooms will be built immediately.

Toronto, Ont.—Applications for loans for the erection of churches and manse totalling \$350,000, have been made to the Board of Home Missions and Social Service of the Presbyterian Church in Canada.

Toronto, Ont.—Mayor McGuire announced that he would shortly introduce a motion calling for approval of the construction of an athletic stadium near the Exhibition Grounds. Estimated cost, \$150,000.

Toronto, Ont.—Sketch plans for an additional six rooms at Humberstone Collegiate were placed before the property committee of the Board of Education. The sum of \$90,000 has been appropriated for this work.

Toronto, Ont.—Separate and bulk tenders will be received until noon, April 8, by J. M. Cowan, architect, 3 Carlton St., Toronto, for all trades required in the erection of St. James School, Jane St., for the trustees of the Toronto Separate School Board.

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Smoky Falls Development on the Sturgeon River

Hydro-Electric Power Plant for Spanish River Pulp and Paper Mills at Smoky Falls, Ont.—Present Installation of 5,200 h.p. in Two Units With Provision for Two More Units—Details of Turbines and Generators

By C. C. IRVINE

President, Spanish River Pulp & Paper Mills, Ltd.

S TURGEON River is the main tributary of the French River system and flows into Lake Nipissing near the western end of the main body of that lake. The drainage basin is slightly less than 3,000 square miles in area, and is largely covered with fairly dense forest growth. Along the lower thirty miles of the river there is an old farming community which cultivates a narrow stretch along the two banks of the river.

The drainage basin is bounded on the North and East by the Montreal River and on the West by the Wah-nipitae River. There are many lakes in the drainage basin which offer good opportunities for the storage of water. The river descends rapidly throughout the greater part of its course and there are numerous rapids and falls.

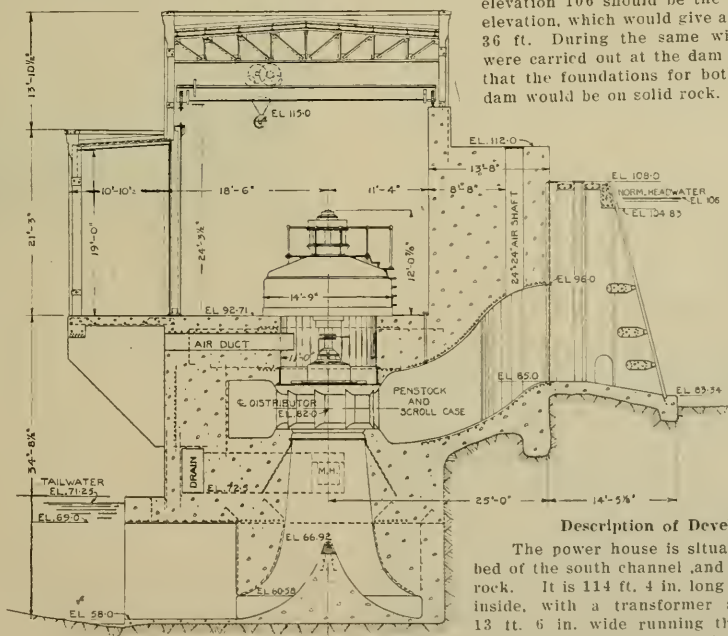
Smoky Falls has a natural drop of about 28 ft., and occurs about 14 miles by river above Lake Nipissing. At this point there is an island which splits the river in two, offering a favorable site for a power development. It is here that the hydro-electric plant of the Spanish River Pulp & Paper Mills, Ltd., is built.

A gauging station was established by the Ontario Hydro-Electric Power Commission two miles above Smoky Falls in 1915, and continuous flow records up to the date of construction (1920) were available for study. The average, minimum and maximum monthly flows for this period are shown in table (1).

Surveys were started in January 1920 to determine the

maximum elevation to which the head water could be raised without causing damage to the farms along the river. All elevations are referred to the local bench mark. The river has a natural rise and fall at the gauging station of eight ft., from 102 to 110 depending on the stage of the river. At the higher stage considerable damage was done to some of the low lying farm land and it was finally decided that elevation 106 should be the normal head water elevation, which would give a head of from 33 to 36 ft. During the same winter investigations were carried out at the dam site, which showed that the foundations for both power house and dam would be on solid rock.

Construction work was begun in May, 1920. In order to facilitate handling material, two miles of spur track were built from Smoky Falls Station on the Canadian Northern Railway to the power house site. The right of way for this spur track was purchased and was later used for the transmission line and wagon road.



CROSS SECTION OF POWER HOUSE,
SMOKY FALLS, ONT.

Description of Development

The power house is situated along the river bed of the south channel and is founded on solid rock. It is 114 ft. 4 in. long by 27 ft. 2 in. wide inside, with a transformer and switching bay 13 ft. 6 in. wide running the whole length of the power house. The sub-structure and head wall are reinforced concrete, and the super-structure is of steel and brick with a poured gypsum roof. The intakes of the scroll casings are each 22 ft. by 11 ft., with a central stream-lined

pler to carry the trash rack supports. Trash racks are 23 ft. long and made up of 4 in. by 5 16 in. bars 2 1/2 in. centre to centre. Moody patent spreading draft tubes are used. The head gates for the scroll casings, two for each unit, are of reinforced concrete cast in place. To relieve the pressure when opening under full head, the upper 2 ft. of each gate is arranged to lift 24 in. before the lower portion moves, thus allowing the scroll casing to fill and balancing the pres-

sure on each side of the gate. In the south channel a log chute with reinforced concrete drop gate is provided for log driving.

Details of Equipment

Two Tainter gates in the south channel and four in the north channel are provided to take care of flood waters.



POWER HOUSE—LOOKING UP STREAM FROM
TAILRACE

Each gate is 14 ft. by 20 ft. with sills at elevation 92. In addition, 80 ft. of spillway with crest at elevation 103, and flash boards 3 ft. deep are provided. The total discharge capacity of all gates and spillway with head water at elevation 109, is 30,000 second-feet; this allows 11 c.f.s. per square mile of drainage area, and as the latter is partially controlled by storage dams, and in view of the existing flow records of the past eight years this is considered ample discharge capacity.

The water wheels were built by the Wm. Cramp & Sons, Ship & Engine Building Co., I. P. Morris Department, Philadelphia, Pa. They are of the single runner vertical type, and are designed to give 2600 h.p. under a 33-ft. head at a speed of 138.3 r.p.m., the efficiency under these conditions being 89%; they are provided with hand-operated breaking mechanism. Woodward oil pressure governors are installed on each unit, and are controlled electrically from the switchboard.



INTERIOR OF POWER HOUSE—SMOKY FALLS

The generators were built by the Canadian Westinghouse Co., and are each 2125 k.v.a., 50 deg. Fah. rise, 3 phase, 2300 volt 60 cycle, 138 r.p.m., with Kingsbury thrust bearing and direct connected exciters; each exciter being capable of exciting two units. For transmission to the

Company's mill at Sturgeon Falls the voltage is stepped up to 22,000 volts. The transforming equipment consists of three 3000 k.v.a., single phase, Westinghouse transformers, oil insulated and water cooled. The cooling water is drawn from any one of the four scroll cases and forced through the cooling coils by a duplicate set of direct connected motor driven pumps. Oil switches are installed for each generator, and automatic oil circuit breakers on both the low tension and high tension side of the transformers, the latter being necessary as there are two outgoing lines. The switchboard consists of seven slate panels and swinging bracket provided with the usual meters. Provision is made for the installation of a Tirrell regulator at a later date.

Auxiliary Apparatus

A motor generator set with sufficient capacity to excite all four units is provided to insure excitation, and there are station transformers for power, lighting and heating. As the station runs on very light load on Sundays it is essential to heat the power house during the winter months when temperatures as low as 30 and 40 degrees below zero are encountered. Electric hoists are provided on both dams for the operation of Tainter and head gates and log chute gate. It is proposed ultimately to install four units but there are only two at the present time.



GATE DAM—NORTH CHANNEL LOOKING UP STREAM
NORTH BANK OF RIVER

TABLE NO. 1

Flow of Sturgeon River at Smoky Falls
November 1914 - October 1921

	Monthly Average	Minimum Monthly Average	Minimum Monthly Average
	c.f.s.	c.f.s.	c.f.s.
November	2780	1790	4290
December	2440	1620	3570
January	1760	700	2580
February	1630	650	2410
March	2020	620	3320
April	6160	3320	9160
May	7500	4530	10520
June	4400	1980	7350
July	2890	2130	5400
August	2110	1600	2960
September	2010	1080	3010
October	2400	1040	3450

Transmission Line

The power is transmitted eight miles to the Company's mill at Sturgeon Falls and is stepped down to 2,200 volts for distribution. The transmission line consists of a wood pole two-circuit line carried on pin type insulators. Poles are western red cedar with creosoted butts and are spaced 135 ft. apart. The conductors are of 2/0 aluminum cable steel reinforced. The telephone line is carried on the same poles and connects the mill and the power house. The transmission line is protected at both ends by type "AK" electro-

lytic lighting arresters. The tanks are placed inside the building and the horn gaps outdoors. The first two units have been in operation since November, 1921, and the plant is giving every satisfaction.

James O. Heyworth, Chicago, was the contractor and engineer for general construction while the spur track and transmission line were built by Messrs. Lang & Ross, of Sault Ste. Marie, and the waterwheels and generators were purchased by the Management Engineering & Development Co., of Dayton, Ohio.

Typical cross sections of the power house and several views of the development are shown.

MUSSENS LTD. OUT OF LIQUIDATION

Firm Passed Into Receiver's Hands Seven Years Ago But Now Pays Last Cent of Debts Then on Its Books

ONE hundred cents on the dollar has been paid to the creditors of Mussen's Ltd., who entered voluntary liquidation in March 1915 upon petition of W. H. C. Mussen, president of the firm. Various payments on account have been made to creditors at different times during the past five years, and about a week ago cheques were forwarded paying the final dividend of 10% and completing the payment in full of all obligations that were on the books of the firm at the time of entering liquidation.

On account of the difficulty of making collections and of profitably disposing of the heavy stock then carried by his firm, Mr. Mussen was forced to apply for a receiver in 1915, but he announced at that time that his liabilities amounted to only \$300,000, with assets estimated at \$550,000. He declared that all creditors would be paid in full, although it would be impossible to realize on the stock and equipment until the depression of the early war period had passed.

Mr. Mussen then declared that the liquidation proceedings were not sought in order to reorganize the business, but for the protection of the creditors, and so that the assets could be preserved against sacrifice and every claim paid in full.

During the seven-year period in which the firm was in liquidation, it received the hearty support of nearly all the manufacturing firms represented before the war, and with one or two exceptions the same firms are still represented by Mussen's, Ltd., and other new lines of railway, municipal and contractors' machinery and supplies have been added. The firm has branches at Toronto, Winnipeg and Vancouver, and all department heads were retained throughout the period of liquidation, so the efficiency of the organization has not been impaired although it proved necessary to reduce the staff materially and to abandon the large show-rooms and warehouse on St. James St., Montreal, formerly occupied by the Company.

The firm of Mussen's, Ltd., was established by W. H. C. Mussen in 1901, and was organized as a joint stock company in 1906.

REID INCINERATOR CO. REORGANIZED

REORGANIZATION of the Reid Incinerator Co., Ltd., Toronto, has been announced, with A. H. Reid as president and manager and T. B. Reid as secretary-treasurer. Offices have been taken at 904 Bank of Hamilton Bldg., Toronto.

The Reid Incinerator Co. was organized a number of years ago by A. H. Reid, who is the designer of the incinerator which bears his name. T. B. Reid, who has just joined the company, recently resigned from the sales department of the Canadian General Electric Co., Ltd., Toronto, and formerly a director of the A. R. Williams Machinery Co., Toronto, and at one time was manager and secretary-treasurer of the latter firm's American company.

Approximately seventy installations of the Reid incinerator have been made in Canada, some installations in-

cluding as high as 39 separate incinerators. These include installations for military camps, hospitals, hotels, public institutions, golf clubs, factories, summer resorts and municipalities. The municipal installations are at Peterboro, Stratford, Sault Ste. Marie, New Toronto, Halleybury, Timmins and Bassano. The incinerators vary in size from the residential type to municipal installations of 50-tons daily capacity.

MONTREAL WATER SUPPLY INCREASED

MONTREAL Water Works was the subject of an address by C. J. DesBaillets, before the Montreal branch of the Engineering Institute of Canada, recently. Mr. DesBaillets, who is a member of the Montreal Water Board, spoke about the low level pumping station and described the alternate systems of water supply. He explained that the system to be used will provide for filtered and chlorinated water, and, in the event of this breaking down, of a chlorinated water supply, to come from the emergency intake which divides in two sections the big concrete intake pipe. The third alternative is a supply of water from the Lachine Canal, so devised that this water will be both filtered and chlorinated.

The speaker explained the change whereby electric pumps had replaced the old steam pumps with their large staz of men and heavy coal bill, and stated that in 1921 the saving had been \$370,000 through the change, based on an average of 72 million gallons per day. When the city would use an average rate of 100 million gallons per day, which would be the case in the near future, the saving of electrically-driven units over steam-driven units will be approximately \$510,000 per year. The operating staff instead of being 90 men, as in the time of the steam-driven pumping plants, is now reduced to seven men, which, he pointed out, adds to the continuity of service, a large factor of safety.

AMERICAN SOCIETY FOR TESTING MATERIALS

DURING the week of June 26, 1922, the Twenty-fifth Annual Meeting of the American Society for Testing Materials will be held at the Chalfonte-Haddon Hall, Atlantic City, N.J. The first session will be held on Tuesday morning, June 27, and the closing one either Friday evening or Saturday morning, July 1. The Committee on Papers has been working for some time on the program of the coming annual meeting and it is expected that a tentative program will be ready about the end of April. Due largely to the fact that 1921 was the year for triennial publication of the Book of Standards, consideration of standards predominated at the last annual meeting. The committee is therefore arranging the program this year to give greater prominence to technical papers and discussions, and to those features of committee reports not dealing with standards.

There will be a number of topics of live interest to materials engineers. Several of these will appear in committee reports; for others, papers are being solicited from members best qualified to discuss them. As much time as possible will be reserved for general discussion, which the committee believes will add greatly to the interest and value of the meeting. A few of the topics that it is expected to develop in this way are: Effect of Sulphur in Rivet Steel, Physical Properties and Tests of Steel Castings, Impact Testing of Materials, Fatigue of Materials, Specifications for Coal, Thermometry, Inspection of Concrete, and Specifications for Concrete and Reinforced Concrete.

Executive officers elected at a meeting of Queen's University Engineering Society were as follows: Honorary president, Prof. L. M. Arkley; president, L. C. Anderson; 1st vice-president, T. D. Johnston; 2nd vice-president, H. Hutchinson; treasurer, E. E. Bryndon; secretary, N. C. Sutherland; representatives, E. Holt, D. A. Henderson, J. E. Brookfield, H. H. Snyder.

EVOLUTION OF TRANSPORTATION*

Development of Transportation Methods by Land and Water
— Motor Buses and Trolley Buses — Electrification of
Railways — Motive Power for Branch Lines

By C. R. Young

Associate Professor of Structural Engineering,
University of Toronto

TRANSPORT in many countries has not progressed very far past the pack animal stage, such for example as in the mountainous districts of Asia and South America. The use of wheeled conveyances is a comparatively modern development in civilization, receiving its great impetus with the construction of permanent roads by the Romans. With such highways available, built although they were primarily for the purposes of war, the development of wheeled transport spread rapidly. The extravagance involved in roads of the Roman or related types, which were often from 2 to 3 ft. thick, precluded the construction of greater mileages in the early days of improved highways. Even with the modification of Tresaguet and Telford, who reduced the thickness, improved highway construction still remained comparatively expensive, and it was not until Macadam proved the soundness of his advanced conception of road building with broken stone that the modern improved highway extended rapidly.

Along with the development of stone surfaced roads there proceeded the idea of special trackway construction. Planking, resting either on wooden sleepers or embedded in the roadway surface, was used as early as 1630 by Beaumont. In some cases metal plates were nailed to the upper surface to decrease the frictional resistance. This was an interesting working out of the old Roman practice of laying two lines of cast stone trackways, which persisted even down to the first half of the nineteenth century when numbers of roads of this type were built in New York State. Cast iron plate ways were first built in England about 1733, and in 1776 John Curr built a cast iron tramway for the Duke of Norfolk's colliery near Sheffield which commanded much attention, and incidentally nearly cost Curr his life through the rioting of the populace who resented any improvements of this nature. While these trackway features were primarily a highway development, they have a vital bearing upon the introduction of steam railways.

Motor Vehicles

As the hardness and smoothness of roadways increased, the idea of mechanical propulsion of vehicles grew apace. Sir Isaac Newton had conceived a simple vehicle propelled by a jet of steam. Savery also suggested a steam propelled conveyance, but Watt curiously enough did not follow up the suggestion. A spectacular achievement, however, was made by Cugnot, who, in 1769, built, in Paris, a steam carriage which was able to carry four persons at two and one-half miles per hour. The smallness of the boiler prevented operation for more than fifteen minutes at a time, and, as one of Cugnot's steam carriages created a great disturbance through overturning at a street corner, it was locked up in the arsenal and nothing further came of it. George Stephenson, sound though he was on matters of locomotive development, scouted the idea of running steam propelled carriages on the highways unless these were provided with special trackways. Nevertheless, a very considerable interest persisted in the mechanical propulsion of highway vehicles, and we find, for example, in 1862, Christopher N. Spencer, inventor of the Spencer rifle, going to and from his work in a steam wagon invented and built by himself. The idea of mechanical transit on highways being established, it remained for the internal combustion engine to solve the problem completely. With it the automobile and motor

truck soon attained their present position of basic importance in highway transport.

Motor Buses

Success of the motor bus in England and elsewhere brought about the establishment of the Fifth Avenue line in New York in 1906 with results that have been entirely satisfactory. The electric railway debacle brought about by rising costs with fixed fares favored the further extension of motor bus traffic. It is said that from 1915 to 1920, ninety-one electric railways operating 5,330 miles, or more than one-fifth of the total electric railway mileage in the United States, went into receivership. In 1920 over 623 miles of electric railway service was suspended and of this 433 miles permanently abandoned. In 1921, 113 miles of service was suspended and 150 miles abandoned. The fact that a large investment must be carried for trackage, overhead construction, and power house equipment, amounting to from 60 to 75% of the total investment, places electric railways under a handicap as compared with motor buses, in one respect at least.

The use of buses is too familiar on this continent to require special comment. In Winnipeg they have been used for feeders to the street railway system since 1918 and in Toronto a number of them are now on trial for a similar purpose. Their value in linking up disconnected divisions of electric railways has been demonstrated both in Canada and the United States.

Trackless Trolleys

The essential lack of economy in power development involved in the use of motor buses, each with its individual engine, suggested the use of a bus deriving its power from overhead trolley wires fed from a central power station. The fact that trackway construction is not necessary for a bus so propelled gives it an advantage over the electric railway. Use of trackless trolleys in England and certain experimental work conducted in the United States caused the installation of vehicles of this type at Norfolk, Va., Richmond, Va., and Staten Island, N.Y., with results that appear to have been successful. The City of Toronto has bought four trackless trolleys of a type similar to those tried out in Detroit and will operate them experimentally for feeder service. Recently the Hydro-Electric Power Commission of Ontario has bought four of these vehicles and is operating them in Windsor, Ont.

Adoption of bus or trackless trolley transportation is of course a matter both of practicability and cost. It has yet to be demonstrated that these methods are thoroughly practicable in northern climates where excessive cold and heavy snowfall might interrupt traffic for a much longer period than with electric railway transport. A good deal of interest is being displayed in the outcome of the experimental operation of these vehicles in Toronto.

A recent study of the comparative costs made by the Public Utilities Commission of the State of Massachusetts gives the following approximate characteristic figures which include taxes and 3% interest on investment: Operating costs of electric car per car-mile, 48 cents; safety car per car-mile, 25 cents; motor bus per bus-mile, 24 cents; trolley bus per bus-mile, 21 cents. According to recent figures the cost of operating motor buses in Winnipeg per bus-mile ranges from 28.5 to 29.2 cents, whereas operating costs per car-mile under similar conditions runs from 32.8 to 36.7 cents. In the Massachusetts figures it should be noted that the capacity of the electric car was 52 whereas that of the other three types of vehicle is approximately 30. While no operating costs for buses in Toronto have been made public, it is understood that the cost so far per bus-mile is greater than the cost per car-mile.

Experience to date appears to show that in general for heavy traffic, motor buses and trolley buses cannot compete with the two-man electric car with its larger capacity. For light traffic and for feeder service these newer means of transport are of distinct value, being capable of operation

*From an address before the Hamilton Scientific Association, Hamilton, Ont.

at approximately the cost of a one-man car, but with greater flexibility.

Steam Railway Development

Early ideas of mechanical propulsion of vehicles shaped towards the perfection of the steam locomotive in the minds of William Symington, William Murdoch, Oliver Evans and Richard Trevithick. The latter, in 1804, put into operation perhaps the first real railway locomotive, running it around a model circular railway in London. He, however, like all his predecessors, was unable to generate steam fast enough to provide continuous operation. Blenkinsop, distrusting the frictional resistance of wheels on trackways, provided a toothed rail engaged by a spur wheel on the locomotive. Engines of this type were used in 1812 with success in the Middleton collieries, operating over a distance of $3\frac{1}{2}$ miles. Thirty coal wagons were hauled at the rate of $3\frac{1}{4}$ miles per hour with this locomotive.

Following the comparative success of Blackett with several engines at the Wylam colliery, George Stephenson, who could neither read nor write until he was 18 years of age, made a number of important improvements in the engines that had heretofore been used. He abandoned Blenkinsop's idea of a cogged railway and in order to generate more steam he turned the blast up the stack, thus greatly augmenting the draft. So successful was his Killingworth locomotive that he was appointed engineer for the Stockton and Darlington railway, a 12-mile coal line conceived of at first as a horse railway, or at most as a railway operated by stationary engines. The locomotive was still distrusted by all except a very few far-sighted men such as Stephenson. In spite of the most violent opposition the Stockton and Darlington railway was opened in 1825, and on this road the first railway coach known as "The Experiment" was operated by horses. The railway company did not itself at first operate vehicles, but let privileges to all those who were able to pay the necessary toll. The remarkable success of the undertaking, however, soon made it necessary for the company to assume operation as well as maintenance of way.

With the success of the Stockton and Darlington railway the line from Liverpool to Manchester, a distance of 30 miles was projected in 1821 and carried out by Stephenson within the following nine years. Even more violent opposition than was offered to the Stockton and Darlington railway was brought out in connection with the Liverpool and Manchester line, engineered, for the most part, by the canal interests who feared competition. Stephenson had the greatest difficulty in securing approval of the charter and in order that he might not be deemed a madman he had to confine his forecasts of speed to ten or twelve miles an hour, although he personally knew that twenty miles an hour was easily obtainable. An interesting feature in the construction of this railway was the famous Rainhill trials of locomotives in 1825, when Stephenson's Rocket, weighing only $4\frac{1}{4}$ tons, including boiler water, eclipsed all other competing locomotives. This little engine ran 29 miles an hour dragging a load of 13 tons after it and covered 35 miles per hour running light.

Following the success of Stephenson, violent speculation in railways arose in the early forties surpassing anything that has ever been seen in Canada. In 1845, Parliament granted powers to build 2,883 new miles of railway, estimated to cost £44,000,000. In 1846, 272 new hills were submitted for railways to a value of £389,000,000, and consent was given for the construction of 4,790 miles at a value of £120,000,000. Similar activity continued for some years after this. The magnitude of these promotions is apparent when it is remembered that there are now in Great Britain only 24,000 miles of railway.

Railways of America

In America railway activity might be said to have begun in earnest with the construction of the Carbondale railway in 1827 when sixteen miles of line were put into operation, partly by the use of horses and partly by stationary engines. The first locomotive in America, the "Stour-

bridge Lion," built in England, was put into operation on this line. In 1828 the Baltimore and Ohio railroad began to operate as a horse railroad, but shortly afterwards was transformed into one operated by steam. The same dispute as had been waged in England concerning motive power occurred on this continent with identical results. Interesting departures from European practice brought about by the topography and financial resources of the country were the heavier grades and sharper curves. Grades were attempted that would have dismayed Stephenson, and the sharp curves made it necessary to utilize the swivelling truck very early.

The first railway activity in Canada began in 1832 when a charter for fourteen miles of line between La Prairie and St. Johns, Que., was granted. This road which was projected to reach Lake Champlain was opened in 1836 and was horse operated on wooden rails. After a year, however, iron rails were substituted and steam locomotives put into use.

In 1852 the Grand Trunk Railway was projected between the Great Lakes and the Atlantic seaboard, and from then on railway construction progressed rapidly.

Motive Power

Remarkable development of the steam locomotive has taken place in the last thirty or forty years. Old "999" which drew the Empire State Express at an average of 64 miles per hour and a maximum speed of $112\frac{1}{2}$ miles per hour has been supplanted by a much heavier type of engine. With the prevailing axle loads it is now impracticable to make such speeds, but the heavier locomotives are able to haul far greater loads at a reasonably high speed than could ever have been attempted by a locomotive of the light construction of "999".

For heavy freight traffic on steep grades the modern Mallet articulated compound locomotive has proved to be a most valuable piece of equipment. The Virginian 2-10-10-2 locomotives of this type with a weight of 342 tons not including the tender are of 4,800 h.p. and are able to exert a tractive force of 147,200 pounds.

Railway Electrification

However efficient the modern steam locomotive may be as compared with its early prototypes, there is an essential lack of economy involved in providing a series of moving power houses for the handling of trains. The consumption of coal per horse power hour is from 6 to 7 lb., by reason of the impracticability of installing all the auxiliary equipment on locomotives that makes for the high economy of a central power house. Apart from this, the efficiency of a steam locomotive varies widely with its age and use, a modern superheated locomotive requiring about 50% more steam per horse power hour at full load than at half load. It must also burn coal while descending grades or when standing by, and when it is remembered that in Canada in 1920 the railways consumed 42.6% of the coal production, the desirability of lessening this coal consumption is apparent. Thorough inspection of a steam locomotive requiring from 4 to 10 hours is required at the end of each run of from 100 to 120 miles to permit the cleaning of fires, the overhauling of machinery, the caking of flues, etc. At the same time the life of an average locomotive is placed at 75,000 running miles.

As against the steam locomotive, the electric locomotive has the reserve of the entire central power house with all its economies behind it and can draw as much power from the line as it needs for the load to be hauled, restricted only by possible overheating. The coal consumption in the central station per horse power hour is only from 2 to $2\frac{1}{2}$ lb., and if hydro-electric energy is used this is entirely saved. A greater ratio of the total weight on the drivers is attainable than in the case of steam locomotives, thus giving a higher tractive effort for the same weight of locomotive. On account of the necessity of less inspection and less repairs than for steam locomotives the repair shop capacity may be cut to about one-third that for steam locomotives and operating divisions may be made from 200 to 400 miles in length. Electric locomotives have been known

to run for nearly a month without going to the round house. There are no water tanks, fuel stations, ash pits or turn tables required under electric operation. Further, the possibility of regenerative braking increases the economy of operation, it having been found in the case of the Chicago, Milwaukee and St. Paul Railroad that under this system from 12 to 16% of the current is returned to the line. A factor of great importance, too, in winter operation is the fact that electric locomotives are not delayed, as steam locomotives often are, by the inability to keep up steam.

Operating results on the electrified proportions of the New York, New Haven and Hartford Railroad; the Butte, Anaconda and Pacific; the Norfolk and Western; the Chicago, Milwaukee and St. Paul, and the Pennsylvania Railroads, have apparently been wholly satisfactory. The extension of the electrified zone of the C.M. & St. P. from an original 438 miles to 647 miles after an operating experience of two years with the first division, would indicate the economic practicability of electrification under such conditions as existed on this portion of the line.

It is not to be assumed, however, that any and every railroad might advantageously electrify, even though a plentiful, cheap and reliable source of power may be available. So great are the capital costs of electrification, amounting in all to from \$30,000 to \$50,000 per mile, that heavy traffic must be assured to meet fixed charges on the investment. Although the Canadian Pacific Railway has been investigating electrification for some time past, it has not been able, so far, to find any portion of its lines that might profitably be electrified.

Motive Power for Light Traffic

So great have been the operating difficulties of the railroads in the past few years that the continuance of branch line service has been in many cases at a great loss. As a result, during the past four years in the United States 4,032 miles of steam railway were abandoned and only 2,700 miles built. During the year 1921 alone, operation of some 1,600 miles of steam lines was either suspended or discontinued. To meet this difficult situation, interesting experiments have been carried out on branch lines in the way of substituting more economical train units than have heretofore been used. For some time a gasoline-electric car was tried out on the Central Ontario Railway, a part of the C.N.R. system, with results that appear to have been successful. An electric storage battery car is now operating on a 63-mile stretch of line between Campbellton and Bathurst, N.B., and is said to be saving \$2,500 a month in operating expense over that required for a minimum steam operated train.

Gasoline motor cars, very similar to motor buses, have been tried out with satisfaction on the Brockville and Westport line of the Canadian National Railway, and on the Cross Creek-Stanley line in New Brunswick, where there is said to be a saving of over \$1,300 per month. The New York, New Haven and Hartford railroad has for some time operated several suburban and branch lines in this manner at one-third the cost of a two-car steam train. In view of the fact that a single car replaces at least a locomotive, tender and combination baggage and passenger car, and that a crew of two replaces a crew of four, the economy of the motor car for light traffic is apparent. Apart from operating difficulties in cold weather, this development is a promising one for light passenger and express traffic.

Railway Construction

Recent improvements carried out by the C.P.R. in the Rockies are instances of progressive railroading so far as line betterments are concerned. A characteristic example is the elimination of the "Big Hill" in the Kicking Horse Pass between Hector and Field. Here 8.2 miles on grades of from 3.5 to 1.5% have been brought down to a 2.2% grade. The lengthening process required two spiral tunnels on 10-deg. curves carried into the sides of Mount Cathedral and Mount Ogden.

Another piece of work meriting particular attention completed by the C.P.R. during the war was the construction of the five-mile Connaught tunnel, the longest in America. This tunnel which pierces Mount Macdonald in the Selkirk lowers the grade at the summit 540 ft. and eliminates 15.54 miles of 2.2% grade, reducing the length of the line five miles and eliminating two long spiral loops and many miles of expensive snow sheds.

Water Transport

Transportation by water has had a long and interesting history from the primitive "goofah" used on the Tigris since Biblical times and the kayak of the Eskimo to the modern Atlantic liner. The turning point in the success of the steam vessel occurred about the same time as that in the success of the steam railroad. In 1788 John Fitch propelled a craft by steam a distance of twenty miles along the Delaware river, and in 1801 William Symmington towed two 7-ton barges along the Forth and Clyde canal in six hours behind the steamboat Charlotte Dundas. Fulton's Clermont, in 1807, covered 150 miles between New York and Albany in 32 hours. Following success on inland waters, attempts were made to propel vessels across the Atlantic under steam power, and this was successfully carried out when the Royal William crossed from Quebec to England in 1833.

Perhaps the most remarkable vessel ever constructed was the 680-ft. Great Eastern built by the great Brunel in 1858, ostensibly for the making of trips to Australia and back without the necessity of recaling. Traffic available at the time was not sufficient to bring success in an economic sense, but the Great Eastern served a very useful purpose in connection with the laying of the Atlantic cables. This vessel was the original unsinkable ship being built, as were post-Titanic ships, with a double skin.

With the development of the steam turbine, oil burning, and the application of the multiple propeller to propulsion, the magnitude of ocean craft has greatly grown, resulting in such ships, for example as the Leviathan with a length of 927½ ft., a tonnage of 54,000 and engines of 90,000 horse power. In a few weeks, the Majestic, 933½ ft. in length, of 56,000 tons, will have made her maiden trip. Since the tonnage of ships increases as the cube of the dimensions, and the power required increases at a less rapid ratio, there is apparently no limit to the size of ships except that imposed by harbor and dock facilities and the traffic available.

Canals

France has been particularly progressive in providing facilities for inland water transport, there now being some 3,000 miles of canals in that country. In the British Isles there is about the same mileage, although these canals have been gradually acquired by the railways and allowed to go into disuse.

An interesting comparison may be made between the outstanding features of the Panama canal and the principal works of the new Welland canal. While the locks at Panama are 1000 ft. long and 110 ft. wide the maximum lift is only 30 ft. In the new Welland canal the locks will be 800 by 80 ft., but each of the seven will have a lift of 46½ ft., so that so far as lift is concerned these structures are the more notable.

The projected improvement of the St. Lawrence raises some vital questions in transportation economics, some of them having an important bearing on the New York State Barge Canal. As an instance of the value of the predecessor of this work in supplying transport before the days of the railway era it is interesting to note that before construction of the Erie Canal it cost \$100 a ton to transport freight from Buffalo to Albany, whereas after the opening of the canal in 1825 the cost dropped to \$3 a ton.

The official inauguration of the Batiscan Bridge will take place next June according to information given by Hon. Antonin Gallepaunt, Minister of Public Works and Labor for Quebec, who will officiate at the event. Ten other bridges built under the supervision of the Government will also be opened during the summer.

CONCRETE ROAD SURFACES*

Maintenance of a Smooth Road Surface — Effect of Temperature Changes on Concrete — Cause of Expansion — Sub-Grade Drainage — Aggregate Uniform in Quality

By L. A. Pardo,
Kent County Road Superintendent.

DURING the past few years a great deal of study has been given to the construction and maintenance of concrete roads, and many splendid articles have appeared in our journals from time to time so that it does not seem probable that anyone can add much new matter of interest. I will therefore only attempt to review the situation as I find it, dealing as closely as possible with the various factors that function for and against the construction and maintenance of an "Intact and Smooth Riding Concrete Surface" on highways.

As soon as we are able to build such a road, of modern and approved design, the surface of which remains intact and smooth throughout its life of twenty years, then we have reached a stage of skill in that particular form of construction almost beyond criticism, regardless of the method adopted in its construction, for after all is it not the surface we are after? It is the surface we see, look at, examine and use and from its appearance we dare to judge much. If we find it in a state of perfection we must be satisfied, for the object of our efforts has been attained.

Such a condition, however, is seldom found, and if we want it we must consider carefully the various factors that work against it and finally a practical method of eliminating them. My remarks are mostly applicable to the construction of concrete roads in suburban areas and particularly applicable to the conditions found in the County of Kent, where the soil is mostly a heavy plastic clay, the country very flat and the ground water level, which is controlled by the adjacent rivers and lakes, about six feet from the surface.

Local Climatic Conditions

In a country where temperature varies over one hundred degrees, great stresses must be expected and the destructive work of this powerful agent is plainly observed not only in every piece of construction for which man is responsible, but in our rugged mountains and on our rocky shores. If a concrete pavement is so constructed that it absorbs any appreciable amount of moisture, subsequent cold weather will cause sufficient expansion to loosen pebbles and minute particles at the surface, which are later whipped out of place by the wind or passing vehicles, thus providing greater facilities for this agent to carry on its work which although comparatively slow, is very persistent and certain to produce holes of various sizes on the surface. It therefore seems that every effort should be made in the interest of permanency to produce at the surface a concrete that will absorb a minimum amount of moisture.

Effect of Frost on Concrete

It is equally important in the interest of a smooth surface that good drainage should be provided so as to reduce as much as possible the percentage of expansion in the ground, beneath the pavement and in the shoulders. Water expands ten percent in freezing. Perfectly dry earth would not show any appreciable effect from frost at all, but such conditions cannot be found or expected so that the rate of expansion in our coldest weather lies between zero and ten per cent, and the nearer it approaches zero the ideal condition, the less will be the disturbance in the foundation of the concrete road. It has been observed that cracks occur usually when the frost is going out of the ground in the spring and not during the period of freezing, or in other words, when the ground is contracting under the pavement. This would suggest to us that during the period of expansion

which is usually gradual the expansion was downward or toward the sides owing to the weight and great strength of the slabs. When the thawing process begins, subgrade and pavement in obedience to the laws of gravity, settle downward, natural beams form in the subgrade on account of its varying compactness producing cracks which open on the surface and admit more moisture if not properly repaired. Once this natural adjustment has been made, future changes are slow to occur usually provided the conditions with regard to drainage and moisture are constant.

The explanation of this subgrade movement during the first twelve months and its comparative inactiveness thereafter, requires some investigation. The majority of breaks that occur in the surface of pavements are due to foundation movements, and not expansion within the concrete itself. I am of the opinion that a critical analysis of any subgrade for a depth of 4 or 5 ft. below the surface would reveal a great variation every few feet in compactness, density and porosity, consequently when the action of frost begins, its intensity will vary in accordance with those conditions producing a network of beams by the ground probably the least disturbed and these conditions obtain once the adjustment is made so long as conditions of drainage remain unchanged. It would seem then that a subgrade of uniform compactness is very essential and that can only be attained by breaking up the roadway to some depth below the proposed subgrade level, disturbing as much as possible all natural arches and pockets formed through ages and earlier construction, and finally recompacting the same by proper rolling.

The climatic conditions of Canada are rather extreme and they present to the Canadian engineer and road builder problems not considered in many parts of the world. The moderate climate of the British Isles is conducive to successful good road construction and particularly their low cost of maintenance, considering the amount of traffic, and again the topography of the country is such as to permit excellent drainage.

Subgrade Drainage

Good drainage should be provided to the subgrade of any pavement in a locality where a freezing temperature obtains for any length of time sufficient to penetrate it. Some soils have natural drainage, and in some localities the natural ground water level is many feet below the surface and some soils are quite impervious, offering almost complete resistance to the transfer of water from the surface to points deeper down where it will not freeze. Some soils absorb a great amount of water and like our heavy, clay soils become spongy and plastic. Owing to the uniform support which the subgrade is intended to give to the concrete slab surely we cannot afford to allow it to saturate and freeze, such a process would be most destructive. Almost all specifications for the construction of large engineering work require that foundations shall go below the frost and that concrete must not be deposited on frozen ground. In the construction of highways, we can eliminate the latter but we cannot go below the frost line for our foundation, consequently our attention should be turned to some practical means of preventing the subgrade from freezing. How can it be done? It is my opinion that the subgrade must be dry, or as free as possible from moisture without which the action of freezing temperature is not much to be feared. The various methods of providing drainage is somewhat beyond the scope of this paper but it has been introduced to suggest how poor drainage in co-operation with the cold weather may be held responsible for the majority of cracks and settled joints almost invariably found on our concrete roads.

Expansion of Concrete

In addition to the destructive effects resulting from poor drainage and cold weather, an extreme range of temperature is responsible for many cracks on account of the expansion of the concrete itself. These are noticeable, particularly at joints where the blocks push together, chipping thin slabs off the surface and at the edge of the pavement a triangular break frequently occurs. Where many sags and

*Paper read at the Eighth Annual Conference on Road Construction, Toronto.

summits occur in the grade "creeping" of the slabs towards the sag may be expected. The extent of such depending upon the grade line and the length of the tangents to the vertical curves. Excessive strains would then be developed in various parts of the slab or block and great compression would occur at the joints towards which the greatest movement occurs.

It is difficult to prevent deterioration caused by expansion alone. Elastic joints are inserted at intervals of from 30 ft. to 50 ft. in accordance with various specifications and practice but the fact that most damage to concrete surfaces on account of expansion occurs at the joints has led many cities and suburban districts in Canada and the United States to abandon their use, except that a joint is made at noon and at night or any other time when pouring operations cease for longer than thirty minutes. However, in a climate such as this, it is difficult to believe that the joint is not of some use in saving the pavement from the effect of expansion.

Foreign Materials

It frequently happens that foreign materials, such as clay, wood, clinkers, coal, coke and bones are found in considerable quantity in the aggregate, and they almost invariably show up at the surface during the first year or two, owing to their specific gravity they work to the top or nearly to it during the finishing process and if not observed by the finishing gang and removed they are covered over by a thin film of grout, which soon chips off, and very shortly conspicuous 'pits' may be observed in the road. Aggregates containing a considerable quantity of such materials should be avoided if we wish to get away from the unsightly holes so often present on the surface of road and sidewalks throughout the country.

Uniform Aggregate

If we wish to obtain a smooth riding pavement we must pay some attention to the uniform quality of the aggregate, that is so far as specific gravity, wear and toughness is concerned. It is generally admitted that a certain amount of separation unavoidably occurs when the batch is deposited, although we talk about preventing it in various ways. It is also a known fact that the softest rocks are the lightest and if sufficient agitation is provided during the finishing operations, it is natural to expect that the materials will arrange themselves in the mass in accordance with their specific gravity, that is the softest on the surface and the degree of hardness increasing towards the bottom. Such an arrangement of aggregate would favor absorption of water, aiding the action of frost, and resulting in wear. Many gravel pits contain an aggregate in which there is a high percentage of stone that can be ground up with ease, this may be expected to cause uneven wear which in turn would increase impact from traffic and further destruction to the surface, giving a rough riding and rough appearing pavement.

Workmanship

In addition to the foregoing causes of poor surface on concrete roads, its riding quality can of course be improved by careful workmanship in setting forms to grade and in finishing, care must be taken to have the surface of the concrete on both sides of the expansion joint at the same elevation, and the finishing, whether it be done by the belt-ting system or by hand, should as far as possible leave no irregularities sufficient to cause impact from vehicles.

At the last monthly meeting and supper at the Green Lantern, of the Halifax Branch of the Engineering Institute of Canada a most interesting paper originally prepared by Capt. R. R. Murray, on war engineering underground in France, was read by Mr. Hardy, Mr. Murray being absent through illness. It dealt largely with work of Canadian tunnelling companies in Ypres sector and was illustrated by slides. It proved one of the most interesting papers the engineers have heard during the year.

ALBERTA PROFESSIONAL ENGINEERS MEET

PROFESSIONAL engineers of Alberta held their annual meeting and banquet at the Macdonald Hotel, Edmonton, on March 25. Past president R. W. Brown, of Calgary, was in the chair, and there were present about 150 engineers from all parts of the province.

It has come to be a recognized fact that the professional engineer occupies a high public place and performs a most valuable service to the community and to the nation, and in all the addresses given during the course of the banquet, this fact was clearly brought out.

Following a toast to the king, proposed by R. A. Brown, Sam G. Porter, engineer in charge of construction and maintenance of the Lethbridge C.P.R. irrigation district, proposed a toast to "Our Country." He summarized the unique position which Canada holds in the world, by virtue of its natural resources, telling of the abundant wealth which, undeveloped, is in the possession of the Dominion. The immense forests, the mineral wealth, the fertile soils which lie within the boundaries of Canada were of untold value.

Premier Greenfield, in replying to this toast, dwelt particularly upon the future development of the province of Alberta.

In proposing a toast to the engineering profession, C. J. Yorath, city commissioner, pointed to the necessity of the professional engineer in rural, urban and national life. He felt certain that the guiding hand of the engineer would contribute in the future to the formation of a national policy which would be for the betterment of economics and industry.

Replying to the toast, R. W. Boyle, dean of the faculty of science in Alberta University, said the engineer is at last assuming his true place in community and national life. Such questions as highways, irrigation, natural resources, and others of vital interest to every citizen, require the expert opinion of the qualified scientist.

Dean Boyle also recommended that a survey be made by competent engineers of all natural resources within the province, soils, forests, minerals, etc. He did not anticipate that the natural resources would be returned to the control of the province within the next few months but it was inevitable that they should in due course, and it was advisable that some idea be gained of their value. He said certain members of the faculty of the University of Alberta had made a private investigation of the value of Alberta's natural resources and had been so impressed with the information secured that they had urged upon the late government the desirability of securing control at the earliest possible date.

WATER POWER ON ST. MAURICE RIVER

WATER powers in Quebec was the subject of an address delivered by Olivier Lefebvre, chief engineer for the Quebec Streams Commission before a largely attended meeting of the Quebec branch of the Engineering Institute of Canada at the Chateau Frontenac, on March 21. He pointed out that the available water power of the St. Maurice river of 500,000 h.p. was along only thirty miles of its course. Its possibilities might equal not less than a million horse power. Mr. Lefebvre touched at considerable length upon the Gouin dam, which, he said, would stand an ice pressure of 50,000 pounds per foot, but strangely enough no ice had formed within a hundred feet of the gates. There was no unanimity of opinion respecting the influence of ice pressure on dams. Arthur Fournier, in the course of an interesting address during the evening touched upon the value of the coal tar industry. He dealt largely with the production of coal tar but dealt with all manners of by-products arising from the industry.

Electrification of railways in Ontario and Quebec was discussed in the House of Commons, Ottawa, recently. Arguments in favor of the scheme were advanced by Homer Deslauriers of Montreal and W. S. MacLean of Toronto.

BITUMINOUS TREATMENTS ON MACADAM ROADS*

Surface Treatments Vary in Character—Thin Coats Recommended—Buying and Unloading Bituminous Material—Distributors—Covering Material

By Alan K. Hay,

Engineer to Ottawa Suburban Road Commission.

SURFACE treatment of macadam roads with some form of bituminous material has now become necessary to prevent rapid deterioration caused by surface stone being ground into dust or mud under ever-growing traffic. If surface treatments are used with discretion, the life of a road is considerably prolonged and maintenance charges are lowered. A good macadam road treated with tar or oil shortly after its construction and consistently re-treated each succeeding year will render excellent service under a very considerable volume of traffic, more especially if the bulk of the traffic is carried on rubber tires. However, heavy horse-drawn loads on steel tires are its worst enemy and in the spring of the year such a surface will cut up badly, if subjected to much of this class of traffic. On the other hand, the tires of automobiles and light or medium sized trucks have the effect of ironing out the surface and do it comparatively little harm.

Surface treatments vary in character from a very sketchy cold application of light oil or tar used as a dust layer to heavy coatings of binder accompanied by a substantial coat of fine crushed stone.

Local Conditions Govern Type of Treatment

The type of treatment for any given road can be decided only by local conditions but in general the most successful type of surface will be one falling midway between the limits above. Partially worn out roads with surfaces showing only a small amount of exposed stone may often have their effective life prolonged a few years by an application of one of the lighter liquids without any covering material. The better class of macadam surfaces should have an application of heavier material which has been heated and should then be covered with a thin coat of stone chips, pea gravel or sand.

On this kind of road, the mistake is often made of endeavoring to build up too thick a carpet or blanket on the road in one operation. The result is a surface which looks well and wears well for a few months and which closely resembles an asphaltic concrete or penetration built road, but in a short time this blanket of tar or asphalt pushes into waves and humps and if there is much horse-drawn traffic to cut it, will often peel from the road metal in large areas.

This unfortunate result may be avoided by applying the bituminous material in smaller quantities, building up a thin skin coat upon which subsequent light treatments may be applied, gradually forming a tough thin film over the road. On a newly constructed macadam road, a treatment during the first season of one-third of a gallon per sq. yd. followed by one-fifth to one-fourth gallons in the following years should in most cases, be sufficient.

A large quantity of material is now on the market which is suitable for applying to the road without heating, but usually it will pay to heat even fairly light oils or tar products in order to secure a greater penetration into the road surface. The slight additional expense and trouble of heating is more than offset by the better results obtained.

Methods and Appliances

There are two ways of purchasing bituminous material, either in tank-car shipments or in barrels and drums. Tank car shipments are by far the most satisfactory and material should not be bought in barrels, unless

the amount of road to be treated is extremely small or railway facilities are wanting.

The average tar or asphalt used for this work may be unloaded from the tank car without heating it, unless the weather is exceptionally cold. Some organizations prefer to heat it in the car by means of a portable boiler connected to the heating coils and then convey it to the road in a distributor which has been insulated in some manner to retain the heat. On my own work, I have found it convenient to unload the material cold and afterwards heat it in the distributor while on the way to the place where it is to be used.

There are several standard methods of unloading. If there is a large amount of road surface to be oiled or tarred each year, and which is concentrated within a fairly compact area of country, it will pay to put in a siding with an elevated trestle, up which the tank car may be run and then unloaded by gravity into storage tanks or distributors.

However, on most work the initial cost of this installation might not be justified, and arrangements must be made to utilize various sidings located as near as possible to the work in hand. In this case a portable pumping outfit is a necessity. There are several excellent pumps on the market designed for the handling of viscous liquids of this nature and if funds are available such a pump would be a good investment. On my own work, we use a make-shift outfit which operates quite satisfactorily under average conditions. It consists of an ordinary good-plunger hand-pump, commonly known as a tank pump, operated by a one and one-half horse power engine and pump jack. As an auxiliary we use a Tarco hand pump, which is a sheet metal affair closely resembling a bilge pump used on boats.

The motor driven pump is connected to the bottom of the car by a pipe 2 or 3 in. in diameter or by a flexible steel hose. The asphalt and tar companies are standardizing their tank cars so that a few standard connections carried in stock will fit most tank cars that are now on the railroads.

Distributors

For the usual amount of work handled by counties, especially when at some distance from the larger centres of population, a horse drawn distributor will prove most economical. Very few counties have a sufficiently concentrated mileage of road to justify the purchase of a large unit mounted on a truck and in addition the ground in the neighborhood of our usual railway siding is of such a nature as to make it difficult for trucks to approach the tank car, more especially after a shower of rain. A horse-drawn machine of five hundred gallons capacity may be operated economically on hauls up to four miles and for longer hauls may be equipped with a short pole and hauled behind a motor truck. On the suburban roads near Ottawa this year we are contemplating equipping a 15-27 tractor with rubber tires for handling distributors on the longer hauls, when the tractor is not engaged on grading work. For short hauls with moderate grades one team of horses is sufficient but if there are many hills two teams will be required. By using two distributors, lower costs will be obtained. One will be filling at the siding while the other is on the road. The investment required is not large, as the average machine with jets, rotary pump, kerosene tank and burners, should not cost much over \$1,000. In purchasing a distributor, an important requirement is that it shall be fitted with an efficient device for straining the liquid before it passes through the jets. If it is not provided with proper screens or strainers, small particles of sand or carbon will block one or more nozzles and cause exasperating delays on the road.

Sweeping

It seems hardly necessary to say that the road surface should be thoroughly cleaned before oil or tar is applied. A horse-drawn revolving broom is of very great

*Paper read at the Eighth Annual Conference on Road Construction, Toronto.

value but should usually be followed by a few men with stable brooms to touch up spots which may have been passed over by the large sweeper. Applying bituminous material on a dusty road almost invariably results in a poor job.

Covering Material

Many specifications call for stone chippings or pea stone as a covering material. If crushed from good hard rock, stone chips make an excellent cover, but if composed of soft lime stone the advisability of using them is doubtful, as lime stone pulverizes very quickly under traffic. Furthermore stone chips or screenings are usually not to be had, or when available are urgently needed for other purposes in the road construction.

Pea gravel or coarse sand are the materials most commonly used. Of these I have found gravel superior as it wears better, gives a gritty surface which provides better foot hold for horses and will not blow away in the first breeze as will much of the sand which is commonly used for this purpose. If screened pea gravel is too expensive, a fine pit-run gravel may be used. It will be necessary to rake the surface of the road to draw the larger stones or pebbles to the shoulder, but this adds very little to the cost of the operation as there are often idle periods for the spreading gang while waiting for the distributor, during which two men with rakes will quickly cover very long stretches of road.

Various systems are used for handling sand or gravel. In town or city work it may be deposited in little piles along the road, twenty or thirty feet apart, from which it is spread direct, by men with shovels. In county work, on roads where there is no curb, these small piles of sand have a tendency to shrink before the time comes to use them, as they are easily dissipated by the traffic. Another system is to dump the sand or gravel in two yard piles, spaced 150 ft. or more apart and rehandle it from these piles, using a couple of one-horse dump carts. Five or six experienced laborers with two dump carts will cover about three-quarters of a mile of 18-ft. road per day under favorable conditions. In this connection it will be found that spreading sand for this purpose is an art in which every laborer is not proficient and the success of which is largely influenced by the skill of the men who do the spreading.

Mechanical spreaders may also be used where conditions are suitable. The amount of cover required may vary all the way from five pounds to twenty-five pounds per square yard and no general rule may be laid down as this is entirely a matter affected by individual conditions on each job. In general the heavier the bituminous material used, the larger will be the amount of cover required.

Costs

The cost per square yard of surface treatment is very largely influenced by the unit amount of tar or asphalt used and by its cost per gallon. Analysis of several jobs last year, where the haul was within four miles and for an application of one-third of a gallon of heated material per square yard, showed a total cost per square yard of from six to seven cents. This included bituminous material, sand, labor and fuel.

CANADIAN SECTION OF WATERWORKS ASSOCIATION TO MEET IN BRANTFORD MAY 12

BBRANTFORD, Ontario, has been selected by the officials of the Canadian section of the American Waterworks Association as the place for the annual meeting for 1922. The dates, May 12 and 13, have been chosen so as to enable members who wish to attend the Philadelphia Convention of the American Waterworks Association to continue the trip with a minimum of expense and time.

The Brantford Chamber of Commerce and other civic bodies are making special arrangements to ensure the success of this event, which will be the second annual meeting of the Canadian section. The program, when completed,

will contain several good papers, and it is expected that important discussions will follow, as was the case at the first annual meeting held last year in Toronto. The papers will include "Filtration Plant Organization," "Government Control of Sewage-Disposal Plants," and "Standardization of Hydrant Threads."

The committee in charge of the meeting has decided to invite waterworks supply firms to exhibit materials and machinery of interest to town and city engineers and waterworks officials. Space will be provided free of charge in a room near the meeting hall. The attendance at the last annual meeting of the section was approximately 125, and included members from all over Ontario and a few from other provinces. Shipments of materials for exhibition should be addressed to the exhibitor, care of the Canadian section of the American Waterworks Association, Chamber of Commerce Rooms, Kirby House, Brantford, Ont. An invitation to exhibit their goods is extended to all Canadian manufacturers whether they are or are not members of the American Waterworks Association. Further information may be obtained from C. D. Brown, Walkerville Waterworks Co., Walkerville, Ont.

NATIONAL HIGHWAY TRAFFIC ASSOCIATION

NATIONAL Highway Traffic Association annual meeting will be held at the Automobile Club of America, 247 West 54th Street, New York City, on Friday, May 12, 1922. The afternoon and evening sessions will be devoted to a consideration of the reports of the following national committees:

Afternoon Session — 2:00 P.M.

Report of National Committee on "Uniform Highway Signs." Chairman, Elmer Thompson, secretary, Automobile Club of America.

Report of National Committee on "Traffic Capacity and Widths of Highways Outside of Municipalities." Chairman, Herschel C. Smith, assistant professor of highway engineering and transport, University of Michigan.

Report of National Committee on "Status of the Construction of Highway Curves and Recommended Practice to Increase Safety to Traffic." Chairman, H. Eltinge Breed, consulting engineer, New York City.

Reports of Executive Committee on "Highway Improvement Creed" of the National Highway Traffic Association.

Informal Dinner — 6:00 P.M.

An informal dinner, at \$1.50 per cover, will be served in the grill room of the Club at 6:00 p.m. The public is cordially invited to attend the dinner. Reservations for the dinner should be sent to the secretary, Elmer Thompson, 247 West 54th Street, New York City.

Evening Session — 8:00 P.M.

Report of National Committee on "Regulations Governing Speeds, Weights and Dimensions of Motor Trucks and Trailers." Chairman, George H. Pride, president, Heavy Haulage Co. of New York City.

Report of National Committee on "License Fees and Motor Vehicle Taxation." Chairman, Henry G. Shirley, roads and sanitary engineer, Baltimore County Roads and Sewerage Department.

Report of National Committee on "Highway Transport Franchises." Chairman, F. W. Penn, secretary, National Motor Truck Committee, National Automobile Chamber of Commerce.

Report of National Committee on "Highway Transport Clearing Houses." Chairman, Tom Snyder, secretary, National Association of Commercial Haulers, Indianapolis.

The Anderson Foundry & Machine Co., Anderson, Ind., manufacturers of the well-known Anderson oil engine, have opened a branch house at 2825 West Harrison St., Chicago, Ill., with R. E. Gray as manager. The Chicago office have on display in their salesroom a 30-h.p., Type-K oil engine, and will attend to the sale of Anderson oil engines in the territory tributary to Chicago.

EARLY PREPARATION OF ROAD BUILDING PROGRAMS*

One Season Work Only a Unit in General Scheme — Primary and Secondary Roads—Advantages in Early Preparation of Work for Season

By Frank Rutherford
Lincoln County Engineer

PREPARATIONS for buildings roads should not be confined to one working season for if such seasonal limit is made there is a strong possibility of having a disjointed product and it would seem to the writer that each year's work should be only one unit in a preconceived structure and that each season's work enters into the scheme only as one step nearer to a final completion of a defined program. We should look upon a road program with a broad understanding of what we ultimately want to do. The whole scheme should be definitely considered and worked out after a careful study of the many things that make up the component parts of a road system. The county road system was inaugurated to provide a better type of road suitable for all the year traffic, leading from centre to centre of population and to give access to the shipping points most frequently used by such populations not centred in urban municipalities.

Primary and Secondary Roads

The earliest preparation necessary would seem to be a comprehensive study of existing conditions, detailing present and anticipated traffic and from such analysis, the route to be followed could be determined. From the same census the importance of the various roads could be ascertained and these roads might be classified into two main divisions of primary and secondary roads. This determination of the importance would then suggest that on a primary road, to carry a more or less accurately ascertained traffic, a heavier and better type of foundation and more lasting surface treatment would be required and provision made for such program before any construction work is done.

The secondary road is not necessarily a through road but should be made as nearly so as possible, although the traffic requirements will practically determine its character.

The whole county road system should be divided somewhat as above, the primary road being the first to be constructed. If this division were made and adhered to, it would make the County more or less accurately determine the financial requirements and enable them to construct such types of road as would ensure a minimum of maintenance charges with a maximum length of service of the road they construct.

Too much stress cannot be laid on this early preparation of the program because it would seem that a great many counties have more mileage of roads in the system than can be economically constructed up to a requisite standard. The tendency is to try and construct all roads in the system without giving enough thought to the primary road without which the secondary road would be of reduced value. Unless such primary road is adequately constructed there is an increased reduction in the usefulness of the work, both primary and secondary..

Program Should Be Prepared Early

The yearly program is only an incidental in the development of the road scheme but is as important in its detail as is the whole general scheme. In this province the climatic conditions are such that there is a sharp break in the building season of each year and this break has led us to consider each season as a unit. As the whole general scheme should be prepared in advance so should the yearly program be prepared well in advance of the actual building season. The building season may be considered as extending from May to October except in exceptionally fav-

orable years and the program for that reason should preferably be determined in the months of November and December. All necessary preliminary data can be then ascertained to so great an advantage in January and February that with the data available from the year previous, the two winter months can be very usefully employed in working out detail which is apt to be neglected when the rush of construction is under way.

Would Help Manufacturers

This early detail preparation would make it possible to have all the next season's requirements of steel for bridges, culverts, guard rails, etc. ordered and delivered at a time when the demand naturally is slack and would have a tendency to better service all round. It would also give the manufacturer some idea of the requirements to be met and he would also prepare his plans accordingly for any portion of the work which would be allotted to him. It would enable him also to produce his goods at a somewhat better standard by allowing his organization to give more and better attention to detail which he could not do when things are ordered in a hurry.

By the early preparation of the yearly program, the superintendent can study out the source of supply of his materials and complete his plans and organization for the most efficient handling of such material, and if the work is to be done by contract it gives the contractor ample time to thoroughly consider the work and to gauge his organization to meet the season's demand. It enables both county and contractor to start at the beginning of the season instead of waiting until a portion of best building season has passed away.

ROAD PROBLEMS IN CANADA

IN AN address before the Ontario Good Roads Association at the recent convention in Toronto, S. L. Squire made some interesting remarks regarding the road problems in the Western provinces. We have in the Dominion of Canada 610,000 miles of surveyed roads. There are in the Province of Ontario 61,000 miles of roads, which include 11,000 miles of colonization roads in Northern Ontario.

In the Province of Alberta there are no less than 250,000 miles of surveyed roads, and in the Province of Saskatchewan there are 210,000 miles of surveyed roads, and in the Province of Manitoba there are 70,000 miles of surveyed roads. We have one third of the population of the Dominion in the Province of Ontario, and yet in the Province of Alberta they have four times the amount of road mileage that we have in Ontario, and they have only one fifth of our population. We have the advantage of some of the other provinces in that we have a more dense population, and we have road material at hand. In Alberta and Saskatchewan, for 400 miles from east to west and 150 miles from north to south there is not sufficient stone, if it were all gathered together to put in a foundation for one road, and that will give you some idea of the problem they have to solve in the matter of road building.

The problem in the Province of British Columbia is a matter of grading and continuity of highway construction. The scattered populations in that province are separated by hills and mountains that are insurmountable as far as road building is concerned. When we consider the problems of the other provinces then we see that the problem that we have to solve in Ontario is not such a very difficult one as we might imagine.

CANADIAN FIRM HAS FORT FOUGE CONTRACT

WORK has commenced in the plant of the Northern Electric Co., Montreal, on the automatic telephone equipment to be installed in the 6,600-line Fort Rouge exchange in Winnipeg. This contract was obtained by the Northern Electric Co. at a price of \$423,254 and will be the first installation of Canadian-made automatic equipment in the Dominion.

* Paper read at the Eighth Annual Conference on Road Construction, Toronto.

Letter to the Editor

ROAD CONSTRUCTION

Sir: The article on "The Structural Design of Pavements," by A. T. Goldbeck, in your issue of February 14, 1922, goes far to indicate the principles that underlie the building of roads to stand up under modern traffic.

There has been a plethora of warnings from the roadmaking practitioner to take care of drainage, as witness the great ditches that flank his roads and now at last the rationale of this phase of road making is being developed. In this connection, may I put forward a few remarks which have a bearing on the problem?

In all roadwork three factors are pre-determined: the soil at the location is unalterable, the surface treatment is dictated by financial conditions, and prejudices, while the duty expected of the structure is the maximum that it can be made to bear economically. The matter thus resolves itself into such treatment or modification of subsurface conditions that will make the total cost during the life of the funding, a minimum.

In the early macadam roads, the effects of moisture and frost soon made themselves evident and Telford took a great step when he placed a layer of rubble under the pavement crust; the cavities forming a sump for the small amount of water finding its way through the cover and preventing the capillary rise of water from the soil.

This is exactly the end to be sought and in my mind the integrity of all pavements will be secured just as soon as a sufficient thickness of a moisture resistant medium is interspersed between the ground and the pavement.

I may quote an example or two to illustrate the point. On a certain Eastern railway built on a cotton soil country, where winter fallowed fields after a couple of days rain allow one to sink to the shovels, stabilizing the roadbed presented a problem. The operation of one of the yards closely followed construction, just as the rainy season commenced and it was very important that delays be reduced to a minimum. The precise conditions being new, a suggestion was made that a light ballasting with sand might at least help and 1 in. to 6 in. of coarse sand was worked under the track with the very best results for during a particularly wet spell the yard was operated without a derailment.

At another location on similar soil and equally mature construction, the following wet season, traffic exigencies prevented the operation of work trains and derailment after derailment occurred due to switches sinking into the mud.

I cannot vouch for the following but believe the facts to be as stated. A certain gravel washing plant for track ballast was designed to remove the whole of the sand from its output. This was put in the track but it was found impossible to keep any surface and only on the re-incorporation of a certain percentage of the sand was the ballast made sufficiently stable.

It would appear from these instances that the moisture content of the ballast must be controlled and the ideal medium between the ground and the pavement must conform to the following conditions:

- 1 That accidental or uncontrollable surface moisture must drain away by the shortest course.
- 2 That the capillary water must be just sufficient to give maximum stability.
- 3 That frost action must be localized so that bulking cannot take place sufficiently to lift the crust.

It is patent that our rural roads at no distant date will have to be macadamized, at least, and this question of the introduction of a modifying medium bears particularly on those that have been made, or are being prepared or extended by men who in general have the vaguest idea of the principles of their work such as councillors and road foremen,

who put a few loads of pit-run gravel in the chuck holes and rutts when the user raises sufficient howl and funds permit.

This pit-run gravel varies by location from a clean river gravel to very sandy pit-run material and I have noticed that in the banks adjacent to the clay and silt "bottom land," the sand gravel predominates. These low grade gravels have maximum capillary action, soak rain in from the surface and draw it from below so that throughout the winter the cover is in the worst possible condition to resist the stresses imposed by traffic. In future the question of finance will practically compel the use of these so called roads as a base for a macadam coating and subsequent failures will impose onerous bond conditions and short life.

With regard to subgrade drainage I have speculated on the wisdom of placing the road, in new work, close against the ditch under such conditions ground water would be levelled more quickly and there are manifest advantages during construction not to mention a possible extension of the season and the convenience to the public.

In conclusion I would suggest the study of track mechanics pari passu with that of pavement physics and urge upon the smaller road authorities, the expediency of having a technical opinion as to their methods and the selection of their materials.

JOHN A. WILSON.

Vancouver, B.C., March 18, 1922.

PROFESSIONAL ENGINEERS

AT THE annual meeting of the Corporation of Professional Engineers of Quebec, held recently in Montreal, the following officers were elected for the ensuing year: A. R. Decary, president; K. B. Thornton, vice-president; F. B. Brown, secretary-treasurer; A. Mailhot, registrar. The other councillors are Arthur Suvever, J. M. Robertson, C. N. Monsarrat, A. B. Normandin and J. E. Gihault. There are now 700 engineers enrolled in the Corporation, an increase of 200 compared with the membership roll at the time of the last annual meeting.

ADVOCATES USE OF LOCAL MATERIALS

ADDRESSING the Rotary Club at the Chateau Frontenac, Quebec, recently, F. A. Hogan, Montreal, manager of the Asphalt and Road Oil Department of the Imperial Oil, Ltd., advocated the use of materials best suited to local conditions, in order to save freight and carrying charges. In the course of his address Mr. Hogan pointed out that Prevost Hubbard, chemical engineer for the Asphalt Association of New York city, would later co-operate with the Department of Public Highways of Ontario to investigate the various deposits of gravel found in Ontario with the idea of utilizing them in the best possible manner. If the results of his trip proved in any way successful the investigations might be extended to the Province of Quebec.

Mr. Hogan said "there is no province which has more deposits of natural lime-stone and other factors which are needed in the construction of various types of road than Quebec. And the main requisites in this type of construction are naturally the ingredients needed to keep out the mud. Any difficulty in this respect could easily be overcome by making a thorough survey of the materials at hand, and having them placed at reasonable prices in keeping with their quality."

The Federal Government has paid \$206,132.20 out of the Federal good roads grant toward the cost of the Hamilton and Queenston highway. The estimated cost of the highway given to the Railway Department for agreement under the Canada Highways Act was \$613,750, for water-bound macadam construction. The cost of laying a bituminous macadam and cement concrete surface on portions of this highway was estimated at \$700,521.50, or a total estimated cost of \$1,314,271.50. The cost to December 31, 1921, for the purpose of securing the Federal grant was \$1,216,651.54.

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E. I. C. COMMITTEE ON POLICY

IN APRIL, 1920, the council of the Engineering Institute of Canada held a meeting to which Ontario councillors and branch and division officials were invited for a discussion of various matters of importance to the engineering profession. One result of the conference was a recommendation that the Institute should appoint a Committee on Policy. This recommendation was subsequently adopted by the council; members representing all provinces were put on the committee, with J. B. Challies, Dominion Director of Water Powers, Ottawa, as chairman. The committee was instructed, among other things, to prepare a statement indicating what should be the policies and objects of the Institute.

The question of remuneration of its members, both by fee and salary, had already been recognized by the council as one of the policies of the Institute. The committee has endeavored by correspondence to reach satisfactory conclusions on the many other questions referred to it, but the different views held by the members have rendered the task of deciding upon its recommendations very difficult. Mr. Challies, in presenting a progress report at the recent annual meeting held in Montreal, pointed out the inherent difficulties and loss of time in conducting a postal discussion. After some consideration it was decided that Mr. Challies be empowered to convene a meeting of the committee. This meeting is to be held in Montreal on April 11, and it is anticipated that by a round-table talk it will then be possible to arrive at conclusions or at least to agree upon the salient points.

The various questions of policy have occupied the attention of many branches of the Ontario Provincial Division

as well as of the council, and it is said to be highly desirable that these matters be discussed by the members of the Committee on Policy, so that some action may be taken. Among the questions that will doubtless be discussed, will be that of the classification or grading of members; that is, whether it be desirable to continue the present classification and titles or to modify them. It has often been expressed that the titles of "associate members" and "associates" are rather ambiguous and confusing. Moreover the classes of "students" and "juniors" may or may not be commendable, and the choice between the title of "member" or "fellow" has given rise to some friendly polemics.

Another question that has been discussed is whether all members should be attached to some branch selected by themselves, or, failing that, by the council, and whether the branch areas should be enlarged and made to constitute the territorial voting divisions. At present there are nearly one thousand members who are not residing in the districts of local branches nor enjoying the fraternal features of any branch. They have very little to kindle enthusiasm in Institute affairs. It is felt by many that it is desirable to corral all members into various branches and to elect councillors as representing the branch districts instead of the present areas.

The students' activities will, no doubt, receive consideration, for the future development not only of the Institute but of the entire profession, must necessarily depend upon the students of today. The "child is the father of the man," and it is conceivable that if the latent forces now more or less dormant in the young engineers are carefully nurtured and directed, the future of the profession will be vouchsafed. The question, however, of how to draw out the best that is in the young men, and to develop their powers for the good of the profession, is one that will require earnest consideration.

IMPROVED SHOWING FOR THE RAILWAYS

SUBSTANTIAL improvement for the year 1921 as compared with the year 1920 is apparent from a study of the summary report for the year ending December 31, 1921, recently issued by the Dominion Bureau of Statistics. Considering the steam railways of Canada with an annual operating revenue of at least \$500,000, which represents over 95% of the total railway mileage of Canada, it is found that the ton-miles of revenue freight decreased 17%, and that the passenger-miles decreased 16%. At the same time the total operating revenues dropped 7%, but by reason of economies in maintenance and other operating expenses the net operating revenue increased by 175%. The result is that the operating ratio dropped from 97.34% in 1920 to 92.14% in 1921. The decrease in both freight and passenger traffic resulting in decreases in revenue is not remarkable when it is remembered that 1920 showed the heaviest freight movement in the history of the railways and the 1920 passenger traffic was exceeded only in 1919, and then only slightly.

As might be expected, the operating ratio is highest for the Grand Trunk Pacific Railway, being 124.03%, as against 170.34% for 1920. The Canadian Government Railways are next in magnitude of operating ratio, with the Canadian Pacific Railway best of all with an operating ratio of 80.9% as against 53.83% for 1920. The Grand Trunk Railway is next to the Canadian Pacific Railway with an operating ratio of 92.61% for 1921, as against 93.58% for 1920.

Considerable anxiety will no doubt be expressed in some quarters should a reduction in rates be sanctioned in the near future. During the months of August, September, October and November last, a considerable spread between revenues and expenditures was maintained, but with the reduction of freight rates effective on December 1st this spread immediately narrowed. It is too soon to determine just what the effect will be, but there is good reason for believing that whatever increases traffic is bound in the long run to be beneficial for the railroads.

ROLLING STOCK ECONOMIES FOR RAILROADS

FOR MANY years an extensive operating experiment has been under way on the Great Northern Railway of England which should suggest a possible economy in the operation of Canadian lines. This consists in the use of articulated units of coaches of which there are over two hundred sets in use on the railway mentioned. While at first the plan was wholly experimental, it met with such notable success that it has been constantly extended until the method appears to have become standard practice.

The economy that has resulted from this remodelling of rolling stock is conspicuous. The ends of adjacent coaches are supported on a single truck rather than on two trucks, as is customary. The coupling pin of the coaches so supported is also the king pin of the truck. Two, five, ten or even more cars may be connected together as a unit or set, there being no definite upper limit so far ascertained. The economy is evident when it is considered that with a set of five-car bodies on six trucks there is a saving over the old system of four trucks, involving not only reduced cost, but reduced length of train, reduction of from 10% to 20% in the weight, reduction in the cost of motive power, and improved riding conditions.

So notable has been the success on the English railroads obtained in the use of articulated trains that it is to be expected some investigation of the practicability of this departure on Canadian railroads will be made in the near future.

PERSONALS

C. H. R. FULLER, city engineer of Chatham, Ont., has been appointed to the new position of city manager. Mr. Fuller will continue as city engineer.

FREDERICK CLARK has been appointed superintendent of the Lethbridge-Northern irrigation project for Grant Smith & Co. and McDonnell, Ltd., who are the general contractors for the undertaking.

W. G. A. ADAMS has been appointed chief engineer and general manager of the Oakland Construction Co., Ltd., Windsor, Ont., a new corporation which has been formed to undertake municipal contracts.

S. L. SQUIRE, of Toronto, chairman of the executive of the Canadian Good Roads Association, was in Ottawa last week in connection with the annual meeting of the Good Roads Association which will be held in Victoria, B.C., in June.

NORMAN J. GOEBEL, engineer for the Board of Water Commissioners, Oshawa, Ont., has resigned. Mr. Goebel went to Oshawa as assistant engineer on May 1, 1920, and on February 1, 1921, was appointed chief engineer by the Water Commission.

N. G. McDONALD, town engineer of Oshawa, Ont., has resigned and has accepted a position with Gore, Nasmith & Storrie, consulting engineers, Toronto. Mr. McDonald was town engineer for eighteen months and during that period was in charge of several important undertakings.

A. L. BALDWIN, who has had charge of the provincial highway operations between Kingston and Prescott, Ont., has been appointed to assume control of the same work on the provincial highway between Brockville and Prescott and on the Prince of Wales highway between Prescott and Ottawa, and will shortly move his office from Gananoque to Brockville, Ont.

GEORGE L. WATSON, consulting engineer, New York City, has moved his office to 150 Nassau St., where he will be associated with the George A. Johnson Co., Inc., consulting engineers. Col. Watson is a member of the Board of Consulting Engineers to the New York State Bridge & Tunnel Commission and the New Jersey Interstate Bridge & Tunnel Commission. He has had a wide experience in mining, tunnel, bridge, harbor and municipal engineering, and served with the British and American armies during the war.

H. L. ROBERTS has entered into private practice in Toronto, specializing in research and development work along mechanical engineering lines. Mr. Roberts is a graduate of the Carnegie Institute, Pittsburgh, class of 1904. He came to Canada in 1912, and was appointed to a prominent position with the Russel Motor Co. Three years later he joined the National Steel Car Co., Hamilton, as chief tool designer, and in 1918 he received appointment as efficiency and inspecting engineer for the Imperial Munitions Board. Latterly Mr. Roberts has been mechanical engineer for Business Systems, Ltd., Toronto. Before coming to Canada he was mechanical engineer for the B. F. Goodrich Rubber Co., Akron, Ohio.

OBITUARY

WILLIAM H. ARMSTRONG, for many years a prominent British Columbia contractor, died in Vancouver on April 2 after a brief illness. He was born in Stratford, Ont., 63 years ago. During the war the late Mr. Armstrong acted as controller for the Dominion Government of the coal mines in Alberta and Eastern British Columbia.

Engineer's Library

AMERICAN WELDING SOCIETY PROCEEDINGS. For some time the proceedings of this society have been printed in the "Welding Engineer," but the society will now issue its own publication, the first being recently off the press. The proceedings contain the usual matter relative to the activities of the society, new membership and a number of technical papers devoted to subjects of interest to welders. The proceedings are published at the headquarters of the society, 33 West 39th Street, New York City.

SECONDARY STRESSES IN BRIDGE TRUSSES. Introducing the Graphic Method of Deformation Contour and its Analytic Solution with Scientific Arrangement of Computations—An abstract of a Thesis Presented to the Division of Science and Engineering for the Degree of Doctor of Engineering, Carnegie Institute of Technology, Pittsburgh, by Thomson Eason Mao. Paper; 6 by 9 in.; pp. 61. Illustrated.

The original thesis of which this pamphlet is an abstract was prepared with the object (1) of treating secondary stresses in a more logical, comprehensive and practical manner than is done elsewhere, (2) of introducing three new methods, two graphic and one analytic, for analyzing secondary stresses and (3) of investigating the effects of secondary stress on the design. In this paper two of the three methods are reproduced, with the materials entirely re-arranged and re-written, followed by a set of principles to be observed in reducing secondary stresses in bridge design.

AMERICAN SOCIETY FOR TESTING MATERIALS. Proceedings of the Twenty-Fourth Annual Meeting, Asbury Park, N.J., June 21-24, 1921. Vol. 21—Committee Reports, New and Revised Tentative Standards and Technical Papers. Philadelphia: The Society; Paper; 6 by 9 in.; pp. 1196; Illustrated; In paper, \$10, in cloth, \$11 and in half-leather, \$12.50.

The present volume of proceedings of this important society is entirely in keeping with the high character previously maintained. It contains the annual reports of 31 of the standing committees of the Society, and 24 technical papers, together with the discussion on these papers and reports. It contains also 93 tentative standards which have either been revised or are published for the first time; the annual address of the president of the society and the annual report of the executive committee. Those who have much to do with engineering materials cannot afford to be without a copy.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Halifax, N.S., highway construction	Apr. 12	
	15 & 18 Apr.	4
Brantford, Ont., road oil, asphalt, Portland cement and castings	Apr. 13	Apr. 4
Calgary, Alta., supply of steel rails and gasoline truck	Apr. 12	Apr. 4
Leamington, Ont., construction of pavement	Apr. 15	Mar. 28
Victoria, B.C., fabrication and erection of part of superstructure of Johnson St. bridge	Apr. 17	Mar. 21
Kingsville, Ont., construction of reinforced concrete, base and stone filled asphalt, or base and bitulithic asphalt, etc.	Apr. 17	Apr. 4
York Tp., Ont., construction of six reinforced concrete culverts	Apr. 17	Apr. 4
Fort William, Ont., erection of school addition	Apr. 17	Apr. 4
Midland, Ont., sewer construction	Apr. 17	Apr. 4
Dunnville, Ont., supply of pumps, etc.	Apr. 17	Apr. 4
Halifax, N.S., gravel surfacing	Apr. 19	Apr. 4
Della, Alta., erection of schoolhouse	Apr. 20	Apr. 4
Halifax, N.S., highway construction	Apr. 20, 22, 24 & 26 Apr.	4

BRIDGES, ROADS AND STREETS

Belwood, Ont.—Following contracts have been awarded by Wellington County Council in connection with the erection of a steel bridge: Steel work, A. Hill & Co., Mitchell, \$9,146; concrete floor, Chas. Mattini, Fergus, \$1,648; abutments, Quinn & Wilson, Fergus, \$4,700.

Brampton, Ont.—William Treadgold, Town Engineer, submitted plans of proposed improvements to Main St. south, to Town Council. The improvements include the widening of the roadway, the erection of a new bridge over the Etobicoke, and construction of retaining walls. Estimated cost, \$33,000.

Bridgeburg, Ont.—Welland County Council has decided to recommend the Garrison roadway site, in preference to the Walnut St. site at Fort Erie, as the Canadian end of the proposed bridge to be constructed by private capital. A bill is pending for this charter at Ottawa now.

Charlottetown, P.E.I.—Provincial Legislature passed a bill authorizing the Province to borrow \$450,000 for road building.

Fenelon Falls, Ont.—Town Council considering the construction of some permanent roadway. Clerk, E. Fitzgerald.

Ford City, Ont.—Concrete sidewalks will be laid this year on Arthur, Giles and Francois Streets, at a cost of \$15,000; concrete sidewalks on Drouillard Road, from the west side of Seminola St. to Tecumseh Road, and on the east

and west sides of Hickory St., from Seminola to Tecumseh Road, at a cost of \$8,000; and a concrete walk on part of the north side of Ottawa St. Clerk, J. F. Foster.

Fredericton, N.B.—City Council decided to grant the petition of M. E. Doohan for the opening up of Aberdeen St. extension through the property owned by Mr. Doohan, between Regent and St. John streets, and the installation of water and sewerage service on this street as soon as possible.

Galt, Ont.—City Council accepted following tenders for annual supplies: Cement, Galt Fuel & Supply Co.; sand and gravel, C. E. Winter; castings, Galt Foundry Co., Ltd.; road oil, Sun Co. of Canada, Ltd.

Guelph, Ont.—Wellington County Council decided to proceed with the construction of the following bridges: Arthur St. bridge at Harrison, a 50-ft. span structure estimated to cost \$6,000; the red bridge at Drayton, 8-ft. span, at a cost of \$10,000; and the Damascus bridge in West Luther, at a cost of \$1,500. All structures are to be of concrete. Council is considering erection of bridges at Mount Forest and Pilkington.

Halifax, N.S.—City Council voted \$151,000 for construction of pavements.

Halifax, N.S.—Contract for the construction of the Shelburne County Line-Woods Harbor Road was awarded to the Provincial Highways Board, the lowest tenderers. Tenders were also received from the following: Engineers & Contractors, Ltd., Nova Scotia Road Builders and Norman E. Smith, W. J. Stuart.

Hamilton, Ont.—Board of Control recommended the paving of Depew St.

Hamilton, Ont.—Civic Works Committee will consider paving of Burlington and Ottawa Streets.

Hamilton, Ont.—Works Committee decided to have Ottawa St. paved, from Beach Road to Burlington St.

Hamilton, Ont.—Road Superintendent T. R. Allison, of Wentworth County, is asking the County Council for approximately \$150,000 for work on the roads this year.

Kitchener, Ont.—Carl Daman, of Kitchener has been awarded contract by Provincial Highway Dept. for construction of two miles of 20-ft. pavement from Kitchener toward Freeport, and the Stewart Construction Co. contract for grading of the highway from Freeport to Preston.

Morton, Man.—Contract for grading roads awarded to Carter-Halls-Aldinger Co., Winnipeg. Total mileage, 27; price, 19½ cents per cu. yd.

Nelson B.C.—Council proposes to submit a road improvement by-law. Clerk, W. E. Wasson.

Niagara Falls, Ont.—The following tenders were received for municipal asphalt plant: Barber Asphalt Co., \$13,374.45; F. D. Cummer & Son Co., \$14,600; Hetherington & Berner, \$14,472; Dominion Industrial Products Co., Ltd., \$12,000; Sawyer-Massey Co., Ltd., \$15,995. All tenders were in Canadian funds, f.o.b. Niagara Falls, excepting that of the Dominion Industrial Products Co., Ltd., who bid on an Austin plant f.o.b. Toledo in U.S. funds.

Ontario, Province of.—Tenders will be received by W. A. McLean, Deputy Minister of Public Highways, until 12 o'clock noon, Thursday, May 11, for various work on the Provincial Highways. (See official adv.).

Ottawa, Ont.—Suburban Roads Commission awarded contract to the Standard Paving Co. for putting an asphalt surface on 3½ miles of the Richmond and Metcalfe roads.

Prince Edward Island, Province of.—Tenders for road

materials will be received until 12 o'clock noon, Friday, April 28, by L. B. McMillan, Secretary of Public Works, Charlottetown. (See official adv.).

Prince Edward Island, Province of.—Tenders for grading and concrete structures will be received by L. B. McMillan, Secretary of Public Works, Charlottetown, until noon, Friday, April 28. (See official adv.).

Orillia, Ont.—Contract for paving parts of Colborne, Neywash and Lacie Streets has been awarded to the Warren Bluminous Paving Co. of Ontario, Ltd., Toronto, for \$90,000.

Peterborough, Ont.—Paving of George St. south is planned. City Engineer, R. H. Parsons.

Port Credit, Ont.—The reconstruction of Brook St. is planned. Clerk, G. W. Gordon.

St. John, N.B.—Council awarded contract to J. E. & P. D. Connolly, Bathurst, N.B., for construction of 1,464 ft. of granite curbing, at \$1.33.

St. Thomas, Ont.—Construction of an entrance to the Athletic Park from Hiawatha St. is to be started this year, simultaneously with the commencement of excavating operations in the street which is to be paved with asphalt this year. City Engineer, W. C. Miller.

Sandwich, Ont.—Essex County Council plans to expend \$577,715 on improving the county roads this year. Road Superintendent, W. H. Kinster, Sandwich.

Toronto, Ont.—City Council will improve Jane St. subway at Lambton Park.

Toronto, Ont.—Proposed extension of Riverdale Ave. was approved by City Council.

Toronto, Ont.—City Council struck out proposed widening and paving of Parliament St.

Toronto, Ont.—City Council gave third reading to by-law for extension of Dundas St. across Yonge St.

Toronto, Ont.—Works Committee considering the opening of a lane in a southerly direction from College St., between Ossington Ave. and Roxton Road.

Toronto, Ont.—City Council sent back to the Board of Control the proposed widening of Bloor St., from Sherbourne St. to Spadina Ave., and from Lansdowne Ave. to Dundas St.

Toronto, Ont.—Tenders addressed to C. Alfred Maguire (Mayor), Chairman, Board of Control, will be received until noon, Wednesday, April 19 for the construction of asphalt pavements, bitulithic pavements, concrete pavements, concrete curbs and concrete sidewalks on a number of streets.

Unionville, Ont.—Markham Township Council has decided to call for tenders for opening up the Markham-Whitchurch town line, from the third concession to Yonge St., at an estimated cost of \$20,000.

Victoria, B.C.—The road construction program this year of the Provincial Highway Department includes the following work: the completion of the Revelstoke-west road, three miles, \$18,000; Arrowhead north road, \$38,000; completion of the Cascade-Rossland road, 19 miles, \$250,000; and the first section of the Nelson-Ymir road between Rosebud and Boundary, tenders to be called May 1. The work contemplated includes Moyle lake road near Cranbrook and macadamizing and completing main Creston highway. Minister of Public Works, Hon. H. H. Sutherland.

Waterloo, Ont.—L. F. Dietrich, chairman of the Board of Works, recommended to the Town Council the paving of Union, John and Allan Streets, from King to Hillow Streets; Mary St., between Union and Allan Streets; and Erb St., between Pepper and Moore Ave.

Welland, Ont.—Welland County Council will spend more than half a million dollars on roads this year, \$640,000 on construction and \$100,000 on maintenance and repairs. Road Superintendent, W. W. Brookfield, Box 1334, Welland.

Windsor, Ont.—City Council intends to construct a concrete pavement on Louis Ave., from Tuscarora St. to Niagara St., at an estimated cost of \$10,807. City Clerk, M. A. Dickinson.

Winnipeg, Man.—City Council intends to construct

granolithic sidewalks on a large number of streets. City Clerk, C. J. Brown.

York Tp., Ont.—Plans for the widening of Scarlett road to 86 ft., both in Etobicoke and York Township, are completed. Work will commence early in the summer. Toronto and York Roads Commission will likely pave the road next year.

WATER, SEWAGE AND REFUSE

Guelph, Ont.—City Council will consider the construction of another trunk sewer from Wellington St. to the average farm. City Engineer, F. McArthur.

Halifax, N.S.—City Council voted the sum of \$150,000 for sewer construction.

Hamilton, Ont.—A special committee of the city council is considering the qualifications of various firms of consulting engineers, with a view to appointing an expert to advise the city in regard to sewage disposal. At a meeting of the committee held on March 24, E. M. Proctor, of James, Proctor & Redfern, Ltd., Toronto, and Wm. Storrie, of Gore, Nasmith & Storrie, Toronto, addressed the aldermen, outlining the experience that the members of their firms have had in sewage-disposal matters. At a later session, Willis Chipman, of Chipman & Power, Toronto, met the committee. Two American engineers, Langdon Pearse, of Chicago, and Harrison P. Eddy, of Boston, are also being considered by the commission.

Newmarket, Ont.—Town Council decided to have sewers constructed in Millard Ave. and Tecumseh St., at a cost of about \$5,000.

North Bay, Ont.—Town Council passed a by-law authorizing the construction of sanitary sewers on Wyld St., between Second Ave. and Worthington St., and on First Ave., between Ferguson St. and Wyld St. Approximate cost, \$17,000. Work will be done by Town Engineer, F. G. Mackie.

Ottawa, Ont.—Contract for construction of Ralph St. sewer awarded by City Council to McLaughlin Bros., for \$6,793. Vitrified pipe is to be used. O'Leary's Ltd., tendered at \$8,325.08, and the city engineer at \$10,315.86.

Ottawa, Ont.—Tenders, addressed to the Board of Control, City Hall, for cement concrete pipe or vitrified clay sewer pipe, will be received until 12 o'clock noon, Tuesday, April 11. Specifications may be obtained at office of City Engineer.

Peterboro, Ont.—City Engineer R. H. Parsons will prepare plans for a new sewer in Romaine St.

Peterborough, Ont.—City will construct the new sewage disposal plant this year at an approximate cost of \$230,000. City Engineer, R. H. Parsons.

Moncton, N.B.—Board of Works recommended that tenders be called for from 20 to 25 catch basins.

Port Credit, Ont.—Work on the proposed water works will be rushed, following the final surveys. Approval of the Provincial Board of Health has been secured.

Scarboro' Bluffs, Ont.—Petitions urging extension of the Scarboro' water system into this area were largely signed at a recent meeting of the Ratepayers' Association.

Toronto, Ont.—The Margueretta St. sewer will be reconstructed at a cost of \$67,950.

Toronto, Ont.—Contract awarded to the Grant Contracting Co., Ltd., 50 Front St., Toronto, for the laying and jointing of water pipes in Bedford Park Ave., Brookdale Ave., Cranbrook Ave., Jedburgh Road, Deloraine Ave. and Lawrence Ave. West, for a total of \$1,106.25.

Walkerville, Ont.—The town of Walkerville has awarded a contract to the Canadian Incinerator & Furnace Co., Ltd., Toronto, to install an up-to-date incinerator with force draft and oil burning equipment complete, this to take the place of their existing furnace which has been in use for some years, using gas as fuel to destroy their garbage. Under ordinary conditions the new incinerator will burn the garbage without added fuel, as is being done at Windsor, Kitchener, Fort William and Transcona, where the company have plants in operation.

York Tp., Ont.—Scarboro Township has offered to supply water to the eastern part of York Tp. The matter was referred to Engineer R. O. Wynne-Roberts.

LIGHT, HEAT AND POWER

Lachine, Que.—City Council will shortly call for tenders for the construction of a transmission plant.

Ontario, Province of.—Sir Adam Beck, chairman of the Hydro-Electric Power Commission of Ontario, announced that the commission has prepared plans, which will be carried out either this year or in 1923, for the construction of a direct high tension steel tower line from the Chippawa plant to St. Thomas.

Orillia, Ont.—By-law to provide \$30,000 by debentures for an extension of the water works system was decided upon recently. Clerk, C. E. Grant.

Oshawa, Ont.—Bell Telephone Co. will spend \$31,000 this summer on the construction of new underground and aerial cables.

Ottawa, Ont.—Ottawa Hydro-Electric Commission awarded following tenders for supplies: Meters, Ferranti Meter & Transformer Co.; globes, insulators and brackets, Canadian General Electric Co.; transformers, Canadian Crocker Wheeler; cross arm braces, solder, junction boxes and covers, cutouts, W. L. Donnelly Electrical Supplies; fuses and conduit, Northern Electric Co.; wire, Garrioch Godard & Co.

Quebec, Que.—A gigantic power scheme involving a capitalization of \$500,000,000 is being mooted here, and parties connected with the project have approached leading business men, including Major Samson, of this city. The mayor was informed that American interests are behind the scheme, who, it was stated, were planning the acquisition of the Quebec Railway, Light, Heat and Power Co. together with the rights to all water powers north of Quebec, with a view to developing enough horsepower to serve the whole province and large sections of the United States. Mayor Samson has declared himself in favor of the scheme.

Windsor, Ont.—Estimating that the total loss incurred by people of the Border Cities, through the two failures of Hydro-electric power which have occurred this winter, must be in the neighborhood of \$500,000, Ald. E. Blake Winter announced that if the scheme appealed to his colleagues in the City Council, he would initiate a movement to secure an auxiliary steam plant which would ensure the border of an unending supply of electricity.

RAILWAYS

Osprey, Ont.—Township Council is agitating for the extension of the C.P.R. line from Saugeen Junction to Osprey and Collingwood Townships.

St. Thomas, Ont.—Contract for laying several miles of rails on the Michigan Central division this year has been awarded to the Hall Construction Co.

Toronto, Ont.—The report on the proposed electrification of the T. & N. O. Railway will soon be submitted to the Ontario Government.

Toronto, Ont.—City Council approved debenture issue of \$10,000,000 for Transportation Commission's reconstruction program and extensions.

Toronto, Ont.—C.P.R. proposes to construct another siding across John St. to serve the premises of J. K. McLaughlin, 275 King St. West.

Windsor, Ont.—C.P.R. plans to spend \$250,000 in Windsor for the improvement of facilities. F. M. Rutter, superintendent of the London division, will award the contract within a few days for the new freight sheds here and the opening of new yards.

FACTORIES AND LARGE BUILDINGS

Athens, Ont.—Tenders for a High School, addressed to the Secretary, High School Board, Athens, will be received

until noon, April 15. Plans and specifications may be seen at the office of the architect, A. Stuart Allaster, Brockville.

Atikokan, Ont.—The following tenders were received for the erection of a two-room Public School building: John East Co., Port Frances, \$17,430; Russell Bros., Fort William, \$18,472; Wyatt-Ireland Ltd., Winnipeg, \$18,603; Thunder Bay Harbor Improvement Co., Port Arthur, \$19,340.81; Street & Holley, Fort William, \$20,921.

Aurora, Ont.—A large addition will be built this year to Aurora High School.

Bolton, Ont.—Town Council plans erection of new Town Hall. Clerk, F. E. Snider.

Britannia Beach, B.C.—Plans for the rebuilding of the town which was destroyed by floods last year, and for rushing the completion of the new, \$800,000 fire-proof concentrator, are being made by N. J. Quigley, vice-president of the Britannia Beach Mining Co.

Brockville, Ont.—Rebuilding of the Athens High School, destroyed by fire, has been decided on, and work will be proceeded with shortly.

Brooklin, Ont.—Erection of a consolidated school is projected.

Calgary, Alta.—A new Crescent Heights Methodist Church will be erected at an initial expenditure of \$12,000. Work will commence about June 1. Address F. E. Graham.

Charlottetown, P.E.I.—Fire destroyed the warehouse of Imperial Oil, Lt., near here. Loss, \$15,000.

Courtright, Ont.—Diamond Crystal Salt Co. of St. Clair, Mich., plan to erect a salt refining plant here at a cost of \$50,000.

Dorchester, Ont.—Plans are under way for the building of a continuation school.

Dundas, Ont.—By-law will be submitted to ratepayers to loan \$15,000 to F. P. Thornton to aid in the erection of a plant.

Edmonton, Alta.—Mayfair Gold and Country Club plan erection of clubhouse. The contracts, which will be let shortly, include the installation of a complete water system for the golf course. Architect, Frank Lansdown.

Elmira, Ont.—Local I.O.O.F. plan construction of building. Tenders are now being called.

Essondale, B.C.—Contract for the erection of Acute Building at Mental Hospital has been let to McDougall-McNeill Co., Ltd., Vancouver. Estimated cost of building when completed, \$600,000.

Galt, Ont.—Enlargement of the Agricultural Hall at Dickson Park is projected.

Galt, Ont.—School Board asked City Council for \$10,000 for remodeling Victoria School.

Galt, Ont.—Ratepayers endorsed the project of an industrial loan to a Toronto woodworking firm which proposes to construct a plant here.

Grant Mine, B.C.—Tenders will be received by Hon. Dr. W. H. Sutherland, Minister of Public Works, Victoria, until 12 o'clock noon, Friday, April 12, for the erection of a two-room school at Grant Mine, in the Newcastle Electoral District, B.C. Plans and specifications may be seen at the offices of the following: J. Mahony, Government Agent, Court House, Vancouver; S. McE. Smith, Government Agent, Court House, Nanaimo; J. S. Peterson, Secretary to School Board, R. R. 1, Wellington; or the Department of Public Works, Victoria.

Hamilton, Ont.—Permit issued to Stuart & Sinclair for addition to factory of the Hamilton Cotton Co., costing \$18,000.

Hamilton, Ont.—Parks Board plans construction of three new sections to grandstand at Scott Park. Chairman, Alfred Wright.

Hamilton, Ont.—Board of Control has favored plans of the hospital governors and officials of the Babies' Dispensary Guild to erect a building on the city hospital grounds to house the outdoor clinics and the dispensary. Estimated cost, \$60,000.

Hussar, Alta.—Tenders will be received until noon, April 15, by Frank J. Harper, Secretary-Treasurer, Crammond S. D. No. 3988, for the erection of a school.

Ivry, Que.—Fire destroyed the Manitou Clubhouse, at Lake Manitou, near here. Estimated loss, between \$30,000 and \$40,000.

Kerrisdale, B.C.—Contract for erection of fire hall awarded to Baynes & Howe, Howe St., Vancouver.

Kingston, Ont.—Work on the erection of a new library building for Queen's University will be started next fall. Estimated cost, \$350,000.

Kitchener, Ont.—Tenders for the various trades in connection with the erection of a laundry building for the Waterloo County House of Refuge, will be received until Saturday, April 15. Plans, specifications, etc., on application to H. W. Martin Manager, or to the architect, W. C. Cowan.

Lindsay Ont.—Board of Education plans addition to Collegiate Institute at an approximate cost of \$60,000.

Moncton, N. B.—Alderman Ambrose Wheeler has received a contract from Carl Doull for the erection of a three-storey, brick faced, terra-cotta building on Robinson St. Estimated cost, \$10,000.

Montreal, Que.—Church of the Sacred Heart, corner Plessis and Ontario Streets, was completely destroyed by fire. Loss, between \$400,000 and \$500,000.

Montreal, Que.—Tenders for the demolition of Knox Church are being called. The Sun Life Assurance Co. will erect a large addition to their present building on this site.

Niagara Falls, Ont.—Tenders close April 12 at 6 p.m. for erection of Hydro transformer station for the Municipal Hydro Commission. Plans and specifications at office of C. M. Porter, 102 Main St.

North Bay, Ont.—Town Council authorized Public School Board to proceed with an addition to the McPhail Street school, at a cost of \$47,000.

Orillia, Ont.—Work has started on the erection of new buildings for the Fisher Motor Co. and the Canada Electric Castings Co., Ltd.

Oshawa, Ont.—Work on the proposed new St. George's Anglican Church will be commenced immediately. Tenders for the excavation have been called. Estimated cost, \$100,000.

Ottawa, Ont.—Work has started on the erection of a garage on the south-east corner of Bank and Catharine Streets for the Beach Motors, Ltd. Approximate cost, \$100,000.

Ottawa, Ont.—Tenders will be received until 6 o'clock, Monday, April 17, by D. Monroe, Sec.-Treas., Board of Public School Trustees, for the erection of a school building. Tenders may be submitted for the complete building, or for the different trades, viz: Plumbing, plastering, carpentry, foundation work etc. Plans and specifications may be obtained at the office of the secretary-treasurer; at the office of Millson & Burgess, Architects, 209 Sparks St., Ottawa; or W. C. Beattie, Consulting Engineer, Ottawa.

Pembroke, Ont.—Separate and bulk tenders will be received until noon, May 9, for all trades required in the erection of Hospital for the Pembroke Cottage Hospital Association. Plans and specifications may be seen at the office of W. C. Keighley, Architect, Grand Trunk Building, Pembroke.

Preston, Ont.—School Board accepted plans of Architect Warren of Hamilton, for a 16-room school, to be erected in units as required, the first unit to be erected this year for which tenders will be called shortly.

Quebec, Que.—Plans have been asked for and tenders will likely be called for an extension to the Court House.

Raleigh Tps., Ont.—Contract for erection of brick school in S. S. No. 6 has been let to Art. Gallagher, general contractor, for \$10,900.

Renfrew, Ont.—Ratepayers authorized the Town Council to pass a by-law for the building of new Collegiate Institute at a cost of \$200,000.

Sarnia, Ont.—City Council passed by-law granting certain concessions to the Dominion Alloy Steel Corporation in return for which the company will erect a \$3,000,000 plant. By-law will be voted on by ratepayers on May 4.

Toronto, Ont.—Separate School Board plans erection of an 8-roomed school in Moore Park, and a 4-roomed addition to St. Vincent de Paul School. Chairman, D. A. Carey.

Toronto, Ont.—Members of the York Masonic Hall Co., Eglinton Ave. and Yonge St., are planning the construction of a large hall on their site on Eglinton Ave., just east of Yonge St., at a cost of \$100,000.

Toronto, Ont.—Tenders, addressed to Herbert E. Moore, Architect, 229 Yonge St., Toronto, will be received until 12 o'clock noon, Friday, April 14 for the erection of school building, Moore Park, for the Separate School Board.

Toronto, Ont.—Tenders will be received until April 24 by J. M. Cowan, Architect, 3 Carlton St. Toronto for an trades required in the erection of Church and Rectory Buildings for the Parish of St. Vincent de Paul, Roncesvalles Ave.

Toronto, Ont.—A requisition from the Toronto University to the Provincial Government for four new buildings, at a cost of \$1,500,000, has been received. This includes a new Forestry Building, Botany and Administration Buildings, a Woman's Building, and additions to the heating plants.

Toronto, Ont.—The erection of the following buildings on Bloor St. is projected: Westminster Presbyterian Church and Sunday School, \$250,000; Manufacturers' Life Insurance Co., \$500,000; Gibson Electric Co., \$20,000; Doctors' apartment, by Addison Johnston, \$225,000; Durant Motors showroom, \$100,000; James Wood, corner of Bellair, \$25,000; Burroughes Furniture Co., \$250,000; Home Bank, \$150,000; and Provincial Museum, \$1,000,000.

Toronto, Ont.—Separate School Board accepted following tenders for erection of a 16-room school on north side of McDonnell Square: H. A. Wickett Co., masonry and cut stone, \$42,000; Thos. J. Sullivan, carpentry, \$28,189; Wm. J. McGuire Ltd., heating and plumbing, \$19,500; E. J. Curry, lathing and plastering, \$4,396; J. J. Glynn, sheet metal roofing and metal ceilings, \$4,930; T. J. O'Connor, painting and glazing, \$4,100; McGregor & McIntyre, structural steel, \$3,067; J. G. Gibson Granite Co. marble and terrazzo, \$4,386; Martin Nealon, electric wiring, \$830.

Vulcan Alta.—Erection of church is projected. Address T. B. Davenport.

Walkerville, Ont.—Permit issued to Bell Telephone Co., for the erection of exchange building, estimated to cost \$52,000.

Welland, Ont.—Universal Casket Co. plans erection of plant at estimated cost of \$40,000.

Wellington, Ont.—Contract for the interior finish for the new consolidated school has been awarded to the Belleville Sash and Door Co., Ltd.

Windsor, Ont.—Tenders are being called by the Board of Park Commissioners for the erection of a clubhouse at Wigle Park.

Windsor, Ont.—Members of Knox Presbyterian Church, London St. and McEwen Ave., contemplate the erection next September of a new church costing \$60,000.

Windsor, Ont.—Contract for construction of an addition to the transforming station has been awarded to Muslow & Gale Contracting Co., Masonic Temple, Windsor.

Winnipeg, Man.—Fire in the warehouse of Chelmskys's, Ltd., caused damage estimated at \$100,000.

Winnipeg, Man.—Work is expected to start next fall by the Canadian Foresters' Holding Association, Ltd., on the construction of a Foresters' Hall, estimated to cost \$300,000. President, A. H. Coppen.

Woodstock Ont.—Board of Management of Woodstock General Hospital plan erection of addition at cost of \$100,000.

Woodstock Ont.—Several continuation schools will be established in this district this year, including one at Hickson, one at Mount Elgin and one in Innorkip and in all probability one at Beachville and another at Embro.

York Tps., Ont.—Township Council authorized debenture issue amounting to \$21,000 for two-roomed school addition in S. S. No. 31.

MISCELLANEOUS

Alberta, Province of.—The following companies have been incorporated under provincial charters: St. Paul Electric Supply Co., Ltd., St. Paul des Metis, \$10,000; Mining and Industrial, Ltd., Calgary, \$20,000; Calgary-Edmonton Diamond Drill Contracting and Developing Co. Ltd., Calgary, \$20,000; Currey Chemical Co., Ltd., Calgary, \$50,000.

Chatham, Ont.—City Council will ask the Dominion Government for a grant to assist in repairing the McGregor Creek breakwater on the point at Tecumseh Park.

Cobourg, Ont.—Dominion Government voted \$21,000 for the construction of the breakwater here.

Hamilton, Ont.—The plan recently presented to Hon. J. H. King, minister of public works, Ottawa, by a delegation from Hamilton for harbor improvements here, will be approved by the minister, according to a dispatch received.

Lethbridge, Alta.—Contract for 875 cu. yds. of plain concrete to the construction of the masonry of the three principal railroad crossings of the Lethbridge Northern Irrigation District, has been awarded to Smith Bros. and Wilson, of Lethbridge, for \$18,918.

Miniota, Man.—Municipality has sold a bond issue amounting to \$9,000 for telephone purposes. Clerk, W. E. Warren.

Montreal, Que.—Sand and Gravel Products, Ltd., has been incorporated under Dominion charter, with head office in this city and capitalization of \$100,000. Walter A. Merrill is one of the directors.

New Westminster, B.C.—Provincial charter has been granted to Builders Supply, Ltd., of this city. Capitalization, \$10,000.

Ontario, Province of.—Following are the names of companies recently incorporated under provincial charters, with head office, capitalization and name of one director: Allen's Construction Co., Ltd., Windsor, \$40,000, David E. Allen; London Bridge Works, Ltd., London \$100,000 Richard G. Ivey; Mack Realty & Construction Co. Ltd., Windsor, \$50,000, Percy A. McKee.

Ontario, Province of.—The following are the names of companies recently incorporated under Provincial charters, with head office, capitalization and name of one director: Doran Construction Co., Ltd., Ottawa, \$100,000, Harold Fisher; Ontario Anthracite Mines, Ltd., Toronto, \$500,000, Richard G. McClelland; Rapid Building Construction Co., Ltd., Toronto, \$40,000, Benjamin Luxenburg; Woodhouse Crushed Stone Co., Ltd., Port Dover, \$40,000, John S. Martin.

Ottawa, Ont.—The following are the names of companies recently incorporated under Dominion charters, with head office, capitalization, and name of one director: Grant Brothers Construction Co., Ltd., Ottawa, \$200,000, Alan G. McDougall; Manganese and Steel Foundry, Ltd., Sherbrooke, \$25,000, Frederick S. Pugg; Northern Architectural Iron Works (Montreal) Ltd., Montreal, \$40,000, John G. Frost; La Compagnie Electrique de Rockland, Ltd., Rockland, \$100,000, Andrew T. Thompson.

Quebec, Que.—City Council decided to extend the drainage system in Charlesbourg Road at an approximate cost of \$3,000.

Quebec, Province of.—Hochelaga Cement Co., Ltd., Montreal, has been incorporated under provincial charter. Capitalization, \$3,000,000. Jos. C. G. Contant is one of the directors.

Quebec, Que.—Hon. Ernest Lapointe, minister of Marine and Fisheries in the Dominion Government, intends to introduce in the House a resolution providing for the advance of sums not exceeding \$1,500,000 for the improvement of terminal facilities at Quebec harbor.

Quebec, Province of.—Following are names of companies recently incorporated under Provincial charters, with head office, capitalization and name of one director: Lake St. John Light & Power Co., Montreal, \$250,000, John A. Mann; Vaughn Construction Co., Ltd., Montreal, \$20,000, John Vaughn.

St. Catharines, Ont.—The cost-plus system which has been in force on Section 3 of the Welland Ship Canal since the war is to be abandoned for the contract system now used on the other section of the canal. Inventory is now being taken on Section 3, and when it is concluded all work on the section will cease and tenders will be called for.

Sherbrooke, Que.—Four by-laws calling for an expenditure of \$445,000 for road improvements, construction of sidewalks, sewers and a bridge over the Magog River on Dufferin Ave. were passed by the ratepayers.

Sydney, N.S.—Contract let to Clarke Foundry Co. by the Cape Breton Electric Co. for construction of new steel smoke stack at the company's power plant on Townsend St.

Toronto, Ont.—Harbor Commissioners awarded contract for concessions at Sunnyside to Archibald & Holmes as general contractors.

Toronto, Ont.—City Council applied for legislation to issue debentures for \$2,000,000 for relief sewers, water main extensions, St. Clair bridge and arena heating.

Toronto, Ont.—Parks Department is preparing to make extensive improvements to Earlscourt Park. It is understood that \$10,000 will be spent in grading, erecting club houses, etc.

Toronto, Ont.—The work of widening Yonge St. from Hogg's Hollow to Holland Landing, will likely be commenced this summer. At the same time the whole stretch of the road will be repaved.

Toronto, Ont.—A large delegation, headed by Mayor Maguire, waited on Premier King and members of the cabinet, at Ottawa, recently, and made a strong appeal for the immediate construction of the viaduct in this city.

Toronto, Ont.—In connection with the Toronto Harbour improvement work, Roger Miller & Sons, Ltd., have the contract for the construction of the breakwater from Dowling Ave. to the Humber, and the Randolph Macdonald Co. contract for the construction of breakwater on the lake side of the Island, east of Manitou Road.

Toronto, Ont.—Works Commissioner Harris was instructed by the Board of Control to decide upon what local improvements are to be cut out in order to bring down to \$3,000,000 the \$3,729,955 program passed by the Works Committee. City Council agreed that works costing only \$3,000,000 would be carried out this year.

Vancouver, B.C.—P. B. Mottley, bridge engineer for the Canadian Pacific Railway western lines, has gone to Montreal to submit final details on the plans for the proposed new C.P.R. pier to be erected at Coal Harbor. It is expected that tenders will shortly be called.

Waterloo, Ont.—Waterloo Light Commission placed an order with the Northern Electric Co. for a fire-alarm system.

There was a big attendance at the annual banquet of the Chatham Builders' Exchange, which was held in the Chamber of Commerce, Chatham, Ont., March 21. The speeches of the evening were given by President Gibbs, of the Provincial Builders' Exchange, Sarnia, and Provincial Secretary Gander, of Toronto. Both of the speakers stated that while the building trades had suffered as a result of the war, the prospects for the present year are very bright and they expected that it would not be long before the country was back to normalcy in the building line.

The contract for rebuilding Louvain University Library, Paris, France, has been awarded to the Foundation Co., New York, who will immediately begin to assemble the necessary plant and materials for active work. This is one of the most important single pieces of reconstruction yet decided upon in the devastated area. It will represent the contributions of approximately one million American students and will be an expression of American interest in the restoration of Belgium. The cost of the reconstruction is to be met by a contribution of one dollar per capita from all of the undergraduate students in the various colleges and universities in the United States.

Tenders Called For



TOWNSHIP OF YORK

TENDERS FOR CONCRETE CULVERTS

Sealed tenders, plainly marked as to contents, will be received by the undersigned up to 10 o'clock, a.m. of Monday, April 17, 1922, for the construction of six Reinforced Concrete Culverts in the Township of York.

Plans and specifications may be seen at the office of the undersigned, 40 Jarvis Street, Toronto.

The lowest or any tender not necessarily accepted.

FRANK BARBER,
Township Engineer.

FRANK BARBER AND ASSOCIATES, LTD.,
Consulting Engineers,
40 Jarvis Street, Toronto, Ont
Toronto, April 1, 1922. 273

TENDERS FOR HIGHWAY CONSTRUCTION

Sealed Tenders, addressed to the Provincial Highway Board, Halifax, Nova Scotia, will be received up to noon on the dates below mentioned, for the construction of the following roads:

- (1) Salem Church, Alma, to Fisher's Corner, Gravel Road, 10.05 miles. Tenders to be in April 20.
- (2) Liverpool Town Line to Mill Village, Gravel Road, 8.77 miles. Tenders to be in April 22.
- (3) From a point one mile east Victoria Bridge, Bear River, to a point 2.9 miles west of same. Gravel Road, 3.9 miles. Tenders to be in April 22.
- (4) Guysboro-Antigonish Co. Line to a point 8.85 miles south towards Guysboro. Gravel road, 8.85 miles. Tenders to be in April 24.
- (5) Pictou-Antigonish County Line to Antigonish Town Line. Gravel Road, 10.2 miles. Tenders to be in April 26.

Plans and specifications governing such work may be inspected at the office of the Highways Board, Halifax, N.S., on and after the following dates:

- No. (1) April 1.
- No. (2) April 5.
- No. (3) April 6.
- No. (4) April 7.
- No. (5) April 11.

Each tender for the work must be on the regular form which may be obtained at the Office of the Highways Board, Halifax, and must be accompanied by an accepted Bank cheque equal to ten per cent (10%) of the amount of the Tender. No interest will be paid on this deposit while it is held by the Board. Should the bidder to whom the contract is awarded, refuse to enter into a contract with the Highways Board within five (5) days after the notice of such award, the amount of such cheque may be forfeited to the Highways Board.

The lowest or any tender will not necessarily be accepted.

W. A. HENDRY,
Chief Engineer,
Provincial Highways Board,
Nova Scotia.—274

PLANT FOR SALE

Shovels:—

- 3—225-B Bucyrus Electric
- 1—225-B Bucyrus steam
- 1—Model 300 Marion steam
- 3—103-C Bucyrus electric
- 1—C-45 Atlantic steam
- 1—Model 60 Marion steam

Air Dump Cars.

Steam Locomotives—18 ton to 57 ton.

Electric Locomotives — 50 tons, 600 volt.

Spreader Plows.

"Industrial Works" Cranes —15 and 40 ton.

Wrecking Crane—75 ton.

Hoists—electric and steam.

Derricks.

Stone Channelers— Duplex, air driven.

Rock Drills — submarine type.

Tripod Drills and Jackman-mers.

Drill Sharpeners.

Air Tools—Miscellaneous.

Drill Steel.

Conveyors and Elevators.

Boilers—locomotive type.

Air Compressors—1100 ft. capacity, motor driven.

Centrifugal Pumps.

Steam Pumps.

Concrete Towers and Equipment—Insley, Lakewood and Ransome.

Steel Forms.

Concrete Mixers—electric driven, 1-yard capacity.

Automobile Trucks.

Motors—25 cycle up to 200 H.P.

Transformers—25 cycle.

Rails, Switches, Frogs and Ties.

10-lever Electric-pneumatic Interlocking Plant.

Poles—cedar.

Piling—fir.

Trolley wire.

Structural Steel.

Timber.

Blocks—rope and chain.

Miscellaneous small tools and Contractors' Equipment.

This plant has been used on the power development at Niagara Falls and is in good condition, some items being almost new. Any item of plant can be completely overhauled and repaired on the ground if required.

Address all inquiries to the Hydro-Electric Power Commission, 190 University Avenue, Toronto, or to Box 245, Niagara Falls, Ontario. —272

CORPORATION OF THE CITY OF VICTORIA, B.C.

JOHNSON STREET BRIDGE CONTRACT NO. 3

Sealed tenders addressed to the City Clerk for the fabrication and erection of part of the superstructure of the above, consisting of a Strauss Basculer span with plate girder approaches, will be received up to 4 p.m. on April 17, 1922.

Plans and specifications may be obtained from the City Engineer by depositing the sum of fifteen dollars (\$15.00), which will be refunded upon the return of the plans and specifications in good condition.

The lowest or any tender will not necessarily be accepted.

E. S. MICHELL,
Purchasing Agent.—277

TENDERS FOR HIGHWAY CONSTRUCTION

Sealed Tenders, addressed to the Provincial Highways Board, Halifax, Nova Scotia, will be received up to noon on the dates below mentioned, for the construction of the following roads:

- (1) KENZIEVILLE-PICTOU-ANTAGONISH COUNTY LINE Gravel Road, 7.84 miles. Tenders to be in April 12, 1922.
- (2) SABLE RIVER-LOCKEPORT. Gravel Road, from Tom Tidney Bridge to Walls' Corner, 8.04 miles.
- (3) HEHRON-MAITLAND. Gravel Road, from a point 1.7 miles North of Yarmouth Town Line, Station 90 to Maitland School House Station 500. 7.77 miles. Tenders for Nos. 2 and 3 to be in April 15, 1922.
- (4) BIG BRAS D'OR-ROSS' FERRY. Gravel Road, 10 ml.
- (5) STEWIAKE TOWN LINE-THRUO TOWN LINE. Gravel Road, approximately 15 miles. Tenders for Nos. 4 and 5 to be in April 18, 1922.

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Toronto Highway Entrance Bridges, at Hamilton

Two Plate Girder Viaducts Built Over Railway Tracks by City — Alternative Entrance Projects — Three Other Bridges Built by Provincial Highway Department — Girders Protected from Corrosion by Guniting

By E. BLAKE ALLAN

City Engineer's Department, Hamilton, Ont.

AT THE close of the year 1919 the Toronto-Hamilton highway was still uncompleted. The Hamilton entrance presented a problem of major importance for three reasons. First, because the present road by way of the Valley Inn hill from the Plains Road to the level of the bay and up again to the summit of the tongue of land on which York Street is built, passing under the Grand Trunk Railway on the way, was becoming increasingly dangerous and costly of up-keep. Second, any remedy for the existing evil must necessarily be a very expensive one. Third, the possibilities of the future development as a park of a spot, which is by nature beautiful, should not be hindered by the erection of any unsightly structure, even to complete a link in our first improved national highway. The problem, then,

consideration, probably because of its relative cheapness in first cost.

Plan B. A fill to be made in conjunction with the C.N.R. over their right-of-way was proposed, but was not considered seriously for long, as the objections were very obvious, and the scheme offered no improvement on Plan A. The proposal was contingent on the construction of the C.N.R. into Hamilton.

Plan C. Another proposal was a bridge, over half a mile in length, to connect what is known as Carrol's Point to York St. just south of the high level bridge. A very desirable feature of this plan was the practically level grade thus obtained from the point at which the concrete at present ends on the Plains Road to York Street. But it would



FIG. 1—REINFORCED CONCRETE DESIGN FOR BRIDGE CROSSING. PLAN D

appeared to be to combine beauty and economy with usefulness, and to evolve the solution without undue delay.

Alternative Schemes

A report of the city engineer, dated April 5, 1920, to the Board of Control of Hamilton urged careful consideration of the problem and outlined various proposals. The approximate centre lines of these schemes are shown in Fig. 3. Their principal characteristics were as follows:

Plan A. The Armstrong hill was to connect what is known as the Hair Pin Turn on the east shore of the inlet to the subway under the Grand Trunk Railway on the west. The road on top was to be 30 ft. wide and 35 ft. above water level. The estimated amount of earth required was 135,000 cu. yd., at a cost probably between \$200,000 and \$300,000. The approaches would have been on 4% grades, the stability of the fill uncertain for several years, the whole structure no addition to the beauty of the spot, and the subway under the Grand Trunk Railway, one of the most unsightly and dangerous features of the old road, would have remained. This suggestion was given a good deal of con-

sideration, probably because of its relative cheapness in first cost.

also have included a road diversion of about half a mile to reach the north end of the bridge at Carrol's Point, and this with a total estimated cost of 1½ million dollars, caused the scheme to be rejected.

Plan D. The McKay plan was a high level bridge with centre line approximately on the centre line of the present fill and small bridge carrying the road at the Valley Inn. The eastern approach was a road diversion along the much debated road allowance between East and West Flamboro; and the western approach was along another old road allowance passing the Hamilton Sand and Gravel Co.'s plant, joining up with York St. just south of the present wooden bridge over the London "Y." In common with the line finally adopted, this plan included the erection of two small steel bridges over the arms of the above mentioned "Y."

Another part of the McKay proposal was, as a future development, to bring in the Waterdown and Guelph roads by a bridge on the site of the new Provincial bridge No. 3, meeting the Toronto highway where it would join the old road allowance north of the plant of the Hamilton Sand and Gravel Co.

This plan for the entrance had practically been accepted, and discussion appeared to centre around the relative advantages of concrete arches, as compared with steel arches; the cost in each case being about \$1,000,000. Illustra-

that the Grand Trunk Railway should pay the whole cost of bridge No. 4 and the city the whole cost of bridge No. 5. Thus, the total cost to the city of Hamilton for bridges will be in the neighborhood of \$450,000.



FIG. 2—STEEL DESIGN FOR BRIDGE CROSSING, PLAN D

tions of the two proposed designs are shown in Figs. 1 and 2.

Proposal Finally Adopted

At this point the route finally adopted was proposed by the provincial highway department. The line leaves the Plains Road not far from the end of the concrete, taking a direction about south-west crossing a ravine and marsh by a bridge 675 ft. long, a small bridge over the main line of the Grand Trunk Railway, then by a bridge 598 ft. long it crosses the old channel to Dundas west of the Valley Inn. So far, the route lay outside of the city limits and the provincial highway department agreed to look after the construction and expropriation of land necessary, the arrangement being that Hamilton should pay the share allotted later. Within the city limits the route was the same as that for the McKay plan and was to be constructed at the city's expense. As before stated, this included two small bridges over the two arms of the London "Y." As one of these was on an old road allowance, the Railway Board later ordered

Though the original idea was to build bridges with 40-ft. roadways, providing for a loading sufficient to carry heavy suburban radials and street cars, the final plans have excluded such a possibility and provide for a 30-ft. roadway. The provincial highway department began work on their bridges during 1920 while the city bridges were not started until the summer of 1921.

Characteristics of City Bridges

Altogether, there were five bridges to be built. They were numbered from the Toronto end, the provincial highway department building bridges Nos. 1, 2 and 3, while the city built Nos. 4 and 5. The present article will be confined to a description of the two latter. Nos. 4 and 5 differing in design only in minor details and their erection having

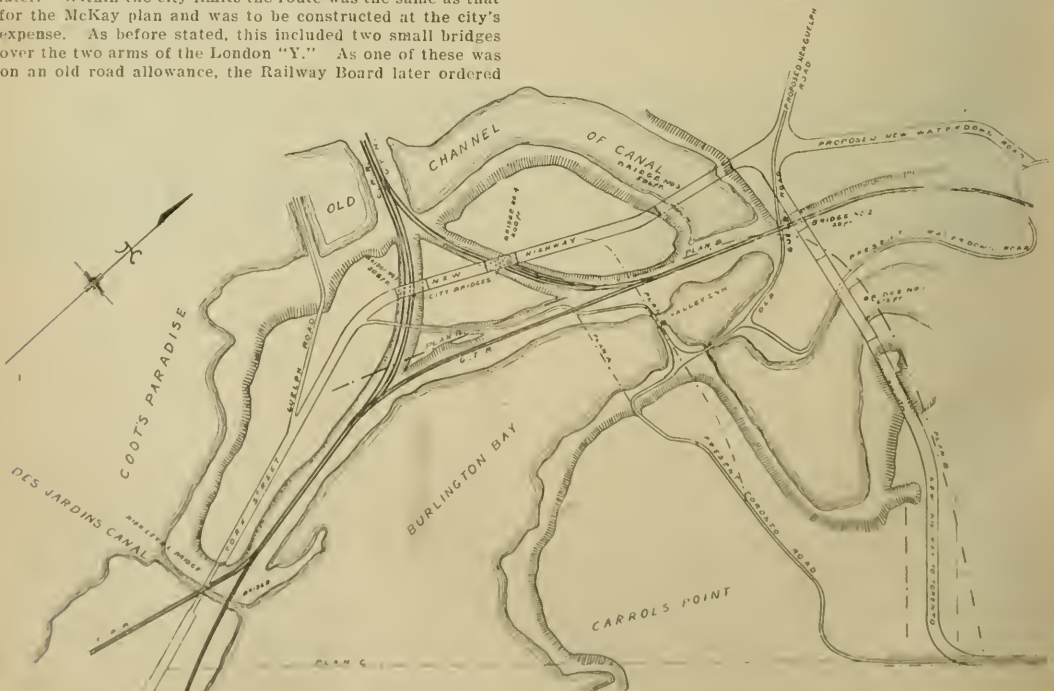


FIG. 3—ALTERNATIVE ENTRANCE SCHEMES OF TORONTO HIGHWAY INTO HAMILTON

gone on simultaneously, will be described as one undertaking except where occasion warrants special mention. Bridge No. 4 crosses the Grand Trunk double track line between Toronto and Detroit, and two sidings. Bridge No. 5 crosses a double track line of the Grand Trunk, though not quite



FIG. 4—FORMWORK CLOSELY FOLLOWING STEEL ERECTION, BRIDGE NO. 4

such a busy one as the other, and a single track line of the Canadian Pacific. Traffic was not delayed for a moment on any of these lines.

Design

As the contracts were not let until about September 1 it was necessary to expedite the work in every way possible to insure that, at least, the main part of the concrete would be laid before the frost came. Broadly speaking, the design was of a steel plate girder, floor beam and stringer type, supported by concrete abutments and piers with a reinforced concrete floor system. As the foundation material consisted of gravel held together with a very firm natural cement, no piling was considered necessary.

The abutments were reinforced throughout, but the piers were mass concrete. Because the road approached both cuttings at an angle, the abutments had wing walls on one side only, while the piers had to be placed in such a way that the main girders were not of equal lengths and the columns were not opposite each other. The minimum clearance in each case was $22\frac{1}{2}$ ft. from base of rail.

The main girders varied in length from 34 ft. to 66 ft. made up of plates $66\frac{1}{2}$ by $\frac{1}{2}$ in., with appropriate flange angles, cover plates, and stiffener angles. These girders were placed 32 ft. centre to centre. The floor beams were also plate girders with webs of $54\frac{1}{2}$ by $\frac{1}{2}$ in., placed centre to centre at distances varying from 12 ft. to 17 ft. to suit the lengths of the main girders. The stringers were 18 in. and 20 in. I-Beams spaced 4 ft. 6 in. centres. The columns in general consisted of special Bethlehem "H"-section 14 in. deep. The floor was a 9 in. slab reinforced concrete laid with a vertical curve from end to end. As the stringers were laid level this curve was obtained by building up a concrete beam along each stringer increasing in height from each end to the centre, the total difference of elevation being 6 in. There was also a drop of 4 in. between the crown of the road and the gutter. The sidewalks were supported by reinforced concrete beams cantilevered over the main girders about 12 ft. centres. The total floor length

was, for No. 4 bridge 208 ft.; and for No. 5, 201 ft.; the width for each being 30 ft. between curbs, with two 5-ft. concrete walks. Allowance was made for 3 in. of asphalt surface on the roadway.

The handrail was of reinforced concrete, so designed that the panels might be precast if desired. The panels were 4 in. thick by about 12 ft. long, having rectangular openings 6 in. by 24 in. spaced 5 in. apart. The panels in the sections on the wing walls of the abutments were solid. The top and bottom rails were 9 in. wide with posts, in general 9 in. by 12 in., by 4 ft. high. At each joint in the main girders an expansion joint of $\frac{3}{4}$ in. was left in the handrail. An expansion joint of 1 in. was provided at each end of the bridge between the concrete floor slab and the abutments. A steel angle 6 by 6 in. by 30 ft. long bent to the camber on the road, carrying lugs to be buried in the concrete protected the concrete of the abutments from chipping on one side of the joint while a similar one protected the concrete of the road slab on the other. The space left was to be filled with some elastic material.

The original design brought the handrails to the abutment only, on one side, and to the end of the wing wall on the other, thus making them uneven in length. Before the contracts were let, this was changed by order of the city engineer so that they were finally built of equal length. The additional piece of rail was supported by a small wall going just below the frost line.

No provision was made in the design for illumination. Gunitite was specified instead of paint as a preservative coating for the steel work, and an extra load of 2,500 lb. per lineal foot of bridge was allowed to provide for its extra weight. This is said to be an innovation in bridge construction in Canada, though often used in the United States. Gunitite was used in this case in order to protect the steel from the deleterious gases of the locomotives passing beneath, with the object of lengthening the life of the bridges.

Contracts and Specifications

Tenders were called for to include the whole job or any distinct part of it such as the concrete, the steel work or the gunitite. In an attempt to expedite the completion of the work, time and co-operation clauses were introduced, night work was enjoined where ever possible, and the work on the two bridges was to proceed simultaneously. A special clause regarding labor set the wage for unskilled men at 50 cents per hour, and skilled men at the union rate.

So far as the main part of the concrete was concerned,



FIG. 5—BRIDGE NO. 4 GUNITED—NOTE FORMS FOR GUNITITE AND HANDRAIL.

the time clause made it imperative that the contractor should have a very large equipment. Fortunately, successful bidders were well situated in this regard.

Only steel made by the open hearth process was to be used as reinforcing. The handrail was to be finished

with a facing of $1\frac{1}{2}$ in. of gray granite chips ranging in size from $\frac{1}{4}$ in. to $\frac{3}{4}$ in. The surface was to be rubbed up with a medium wire brush to bring the granite chips into relief and finally it was to be given an acid wash.



FIG. 6—GUNTING MAIN GIRDERS, BRIDGE NO. 4

Special clauses concerning gunite will be found later under the heading of "Gunite."

Removal of Old Bridge

Part of the contract for the steel work consisted in the removal of the old bridge on the site of bridge No. 4 and its temporary erection again where it would be out of the way of the new work, but would carry the traffic which formerly used it, for the time being. This old bridge consisted of two steel girder spans of about 50 ft. each, supported on wooden bents, having a wooden plank floor, and wooden approaches at each end.

On Aug. 15 the contract for the steel work was let and the bridge company arrived on the ground on Aug. 18. A clause regarding the old bridge stated that traffic must be held up for only 36 hours of two nights and one day. Thus it was necessary to prepare the approaches first and leave only what work was absolutely necessary for the 36 hours specified. On Sept. 2 they had two derrick cars on hand and began the removal of the bridge. Traffic was only held up for 57 hours.

Concrete and Excavation

The contract for the concrete and excavation was let Sept. 6, and the Russell Construction Co. began work on Sept. 12 on both bridges. As the engineers had been on the job for a month before and the whole work was staked out and ready, a big force was able to set to work at once and thereafter the work went on for about 18 hours a day till the completion of this contract. The contractor had 21 days to complete the abutments and piers and was able to strip all but the south abutment of bridge No. 5, within that time.

This delay was caused by circumstances over which the contractor had no control. Such rapid construction could only have been accomplished by a contractor with a big equipment. For part of the time there were 4 mixers and 4 derricks in operation, and 50 men at work. At night, search lights and strings of large size electric bulbs were used, and everything done to make the work move along with a swing. In the excavation for the south abutment of bridge No. 5 dynamite had to be used continually, because of the natural cement in the gravel. Water-tightness was insured at the construction joints in the concrete of the abutments above ground line by the insertion of sheets of metal set vertically.

Erection of Steel

On Oct. 11 the bridge company began erection of steel on bridge No. 4. By Oct. 20 the erection was complete, everything fitting nicely into place. One thing which ensured this was the proposal from the bridge company that bolts should not be put into the bridge seats till after the girders were in place, at which time they would themselves drill the holes in the concrete and set the bolts.

On Oct. 20 the steel contractor began the erection of steel on bridge No. 5, and drove the last rivet on Oct. 27. The good time made by the erection gang was rather remarkable when one considers that for about one-third of the time the derrick had to be running about dodging trains.

Road Slabs and Sidewalks

Before the riveters had reached the centre of bridge No. 4 the carpenters of the Russell Construction Co. were hanging the forms for the sidewalks over the sides of the main girders. This is well shown in Fig. 4.

The device used to support the form for the curb in order to allow the sidewalk and floor slab to be poured at the same time is perhaps worthy of note. Small blocks 3 by 3 by 2 in. were made of concrete, having round iron rods sticking up just far enough to hold up the curb form to its proper height while embedded 2 in. deep in the wood. These blocks were set up every 4 ft. along the curb line on boards forming the form work for the floor, and the curb form placed on the top of the short pieces of iron rods. The gutter was laid later when this curb form was removed. This scheme enabled the road and sidewalks to be poured as a monolithic slab. No construction joints other than those in a transverse direction straight across the bridge were allowed. The reinforcing was in the shape of



FIG. 7—ERECTION OF BRIDGE NO. 5 ALMOST COMPLETED

rods laid from side to side of the bridge held in place by smaller rods running parallel to the centre of the road. Every rod was well wired into place. In the placing of these rods one might observe the wisdom of the old saying, "More haste less speed." The concrete of the floor slab was

poured as nearly continuously as possible, the work going on night and day with a mixer at each end of the bridge. The gutters were finished just in advance of the frost.

Handrail

The panels of the handrail were in process of being precast in the plant of the Concrete Pipe and Products Co. near by, while the other work was going on. The first plan was to use red granite chips as a finishing coat, but gray granite was finally decided upon as more in keeping with the appearance of the rest of the bridge. The rubbing up of the panels was left till they were put in place on the bridge.

As soon as the sidewalk would bear it, the contractor began to work on the lower rail and pushed it along as fast as weather conditions permitted. The work only reached the stage of the completion of the lower rail when cold weather prevented further operations. The city engineer therefore ordered the work to be closed down for the season. The uncertainty of the setting because of frost made the rubbing up difficult.

Guniting

Special provisions for the application of gunite were: Sand to be no larger than $\frac{1}{4}$ in. mesh; mixture 1 part of cement to 3 of sand; water pressure to be 20 lb. higher than the air pressure; reinforcing to be expanded metal or equivalent, 34 lb. weight per 100 sq. ft.; expanded metal to be kept $\frac{3}{4}$ in. from the surface of the girders except at the edges where it was to be drawn tight; thickness of gunite to be 1 $\frac{1}{2}$ in. on all main surfaces and 1 in. on all edges; finish to be natural gunite surface without irregularity. As it was a new thing in the neighborhood, 18 months' guarantee of workmanship was asked of the contractor.

The Gunite Co. arrived on the scene and began work Oct. 14. They, like the Russell Construction Co., had trouble with their water supply, and for various causes, were delayed in their work till the frost overtook them, when their part of bridge No. 4 was just completed.

Before the steel shapes left the bridge works, holes were bored in the webs 2 ft. apart in order to permit the expanded metal to be fastened securely. The contractor suggested the use of $\frac{1}{2}$ in. rods wired through these holes, with the expanded metal wired to the rods at intervals of 6 in. to 8 in. This plan was adopted and proved satisfactory. Though the expanded metal proved entirely suitable where no corners had to be turned, such as between the stiffeners on the webs of the main girders, yet where it was necessary to bend it around corners the stiffness made it very difficult to handle. At certain places triangular mesh of 34 lb. weight was used and proved very adaptable and suitable for all corners bending at once to place.

The specified thickness of gunite though easy to put on the webs of all shapes, was found impracticable in the case of the flanges of the smaller members, and 1 in. on the edges was only possible when forms were used. It was noticed that screeding had a tendency to draw the gunite away from its close bond to the steel of the girders and reinforcing. This should therefore be avoided wherever possible.

The contractor on his own initiative placed forms on the outside of the main girders as shown in Fig. 5. This gave a very pleasing result taking away, in some measure, the appearance of the steel member. One thing which is said to be unavoidable, and which is not very pleasing to the eye, is the tendency to form here and there white patches in the natural khaki color of the gunite. Fig. 6 shows the guniting operation on bridge No. 4.

The weather prevented a start in guniting being made on bridge No. 5, but Fig. 7 shows the erection of the steel-work practically complete.

During a large part of the time the contractor had the services of an expert nozzle man whom he secured from the Cement Gun Co., of Allentown, Pa.

The photographs of the work in progress are supplied through the courtesy of a member of the city engineer's staff, by whom they were taken. The history of the project

was obtained from various reports, plans and other sources of information in the office of the city engineer.

The work was carried out by E. R. Gray, city engineer of Hamilton, through members of his staff. H. V. Thompson, consulting engineer, Toronto, was designing engineer. The writer was resident engineer, and in addition an assistant and two inspectors gave their full time to the work, while the deputy city engineer visited the job daily. The Russell Construction Co. were the contractors for the abutments, piers, floors and handrails; the Hamilton Bridge Works Co., Ltd., for the steel work; the Gunite Co. of Canada, Ltd., for the guniting, and the Concrete Pipe and Products Co., Ltd., of Hamilton, for the handrails.

ROADS IN MIDDLESEX COUNTY

THERE are 490 miles of county roads in Middlesex County, which are classified as follows: Suburban area roads, 28 miles; Provincial county roads, 50 miles; ordinary county roads, 412 miles. There are 2,250 miles of roads of all kinds in the county, 98 miles of which are provincial highways.

In connection with the provincial highway work attention is being devoted chiefly to permanent culverts, larger bridges, improvement of grading and resurfacing with gravel. During the year 1921 5 $\frac{1}{2}$ miles of concrete road 20 ft. wide were constructed from London to Lambeth, the cost of which amounted to \$310,000. This work will be gradually extended until the heavily-travelled proportions are paved.

The county road work up to the present has been the extending of the present system of gravel roads to outlying districts and the maintaining of old gravel roads, constructed shortly after the organization of the district, into the county system.

In 1906 the county initiated a county road system and expenditures that year amounted to \$30,000. The mileage of roads in 1906 was 240. Since that time the mileage has extended to the present amount and the cost has increased from \$30,000 in 1906 to \$217,000 in 1921. The same sum as last year will be spent on the roads this year.

The township roads are paid for by a direct assessment on the ratepayers of 80 per cent. of the cost and the balance by a subsidy from the Provincial Government. Sixty per cent. of the county roads are a direct charge against property owners and 40 per cent. is paid by the Provincial Government. On provincial county roads the Provincial Government pays 60 per cent. and the county 40 per cent. The county suburban area roads are paid for by the city contributing 30 per cent., the county 30 per cent. and the Provincial Government 40 per cent.

The provincial county roads in suburban areas are paid for by the city contributing 20 per cent., the county 20 per cent., and the Government 60 per cent. The Sarnia Gravel road west is in this class.

CRAMP CO. NOW OWNS PELTON CO.

CONTROL of the Pelton Water Wheel Co., San Francisco and New York, has been purchased by the William Cramp & Sons Ship & Engine Building Co., Philadelphia. The Pelton company will retain its old corporate name, and no material changes of policy are contemplated, but new officers have been chosen, as follows:

President, H. B. Taylor, vice-president of the Wm. Cramp Co.; vice-president, Ely C. Hutchinson, formerly chief engineer of the Pelton Co.; second vice-president, W. M. Moody, consulting engineer to the Wm. Cramp Co. Mr. Hutchinson will act as general manager.

This merger combines two of the oldest manufacturers of hydraulic prime-movers. The Pelton company's most important work has been the building of impulse wheels and high-head reaction turbines, while the Cramp company's work has consisted mainly of large low-head reaction units.

WATER SOFTENING AS A FACTOR IN MUNICIPAL SUPPLY*

Soft Water Better for Domestic and Manufacturing Purposes
—Soap Consumption Reduced—Lime a Useful
Agent in Water Treatment

By Wm. M. Barr,

Consulting Engineer, Union Pacific System

IT is almost an axiom that a good water supply is essential to the prosperity of a municipality. Great improvement has been made in recent years in the quality of water supplied even in the smaller towns and villages of the country. This improvement has been largely the result of the growing understanding of the direct benefit to be derived in the health of the people by the use of good water. It is natural then that the first great improvement has been along sanitary lines. There is no longer any excuse for epidemics of typhoid resulting from contaminated water supply since modern methods of sterilization are able to assure us a safer water at a nominal expense.

Frequently, however, an adequate volume of water cannot be had except from streams which may not only be polluted by organisms, but usually carry a considerable quantity of suspended matter, which makes the water distasteful in appearance as well as unpalatable. This condition has been improved by filtration, which in combination with sterilization has been brought to such a degree of efficiency that it is within reach of even the smaller communities. As civilization advances our demands are more exacting and all of our requirements reach a higher and higher plane as the possibilities for satisfying requirements are made easier.

While public officials have given considerable attention to sanitation and public health, by delivering to the people a safe water and one of good appearance, it is rare to find city officials considering the comfort of the housewife, the convenience of the manufacturer or the economics of his factory when making provisions for municipal water supply.

Some of our cities have been especially blessed by nature by having a pure, clear, cold, soft water delivered almost at their doors under ample pressure with nothing left to be done but to install the distribution system. Such a city is Portland, Oregon, where the melting snows of Mt. Hood collect in a natural reservoir and discharge into a stream at an elevation far above the city. This stream is well protected and the pipe line collects the water at such an elevation as to give satisfactory distribution. This water is as near to absolute purity as nature can supply.

Soap Consumption and Water Supply

Analysis show less than 1.5 gr. of dissolved mineral solids per gallon with practically no organic matter. This is an ideal water for all purposes and is one of the cheapest supplies in the country. The absence of hardness in this water makes the soap consumption of this city one of the lowest in the country.

Other cities have had to bring their water hundreds of miles at great expense to provide even a safe water supply of ample proportions. Los Angeles brings its water from a source 265 miles distant at enormous cost but has a good sanitary supply. This water contains 1.65 lbs. of soap destroying material per 1000 gal. of water. This will consume 1.1 lbs. of good laundry soap costing 10c or more. If used for household purposes this must be added to the cost of the water.

Omaha city water contains about 3 lbs. of soap destroying material per 1000 gal. of water although it varies considerably with the season and at times contains more than this. For a little more than one cent per 1000 gal. most of the carbonate hardness could be removed and the soap consumption be thereby reduced at least 60%.

The same is true of most of the cities using Missouri

River water and as coagulation is required on this water, demanding large settling capacity, it is only necessary to add proper equipment for feeding lime.

It has been estimated that it would cost the city of Omaha \$150 per day to treat the water as suggested. If 10% of the total supply is used with soap there would be a saving of \$500 per day in the cost of soap, to say nothing of the comfort and convenience derived from soft water.

While waters from middle western streams are looked upon as being unusually hard, there are some towns even less favorably located where underground waters are used. And while the water is perfectly clear and sanitary it carries so much material in solution that the stranger wonders what the people in that locality do when they want a bath.

If a manufacturer is considering the possibility of a new location the city having a pure soft water will be given preference over the one having hard water, assuming that other conditions are equal. It is, therefore, to the advantage of a community as a whole to offer a satisfactory industrial water supply to those who are seeking locations for new industries. But the manufacturer is not the only one to be considered, nor should it be so. If you consider the greatest good to the greatest number, we should reach all classes of citizens and there are few in any community who do not use soap. If there be such I will venture to say he would not object to taxation on that ground.

Many people will say that softening a municipal water supply is too expensive. The city of St. Louis has not found it so, and they produce more than a hundred million gallons of soft water per day. It is a noteworthy fact that people going to that city from many other middle western points comment favorably upon the soft character of that city's water supply. The total hardness is reduced approximately 60%. I do not mean that it would be feasible to remove all of the scale forming salts from the city supply, but the removal of the carbonate hardness makes a vast difference in the washing qualities of water, and adds much to the comfort of the people, and while the people may pay a premium on such a water they are simply transferring the charge to the water account from the soap account. It is certainly cheaper to remove the carbonate hardness with lime than with soap. Most of the cities that treat their water supply in this way do not attempt to remove all the carbonate hardness as some consider it more palatable if all the hardness is not removed. If the water is well aerated, this objection does not hold.

Advantages in Using Lime

In addition to this there are other advantages to be gained in the water purification process itself by the use of lime, which is added primarily for the purpose of softening the water. Omaha has a water system in which filtration does not play a part, and as a result there are times when this water is not perfectly clear. It is possible by using a sufficient amount of lime to remove a large portion of the carbonate hardness, to obtain a clear water even with a reduction of the amount of alum used for coagulation.

My attention was recently called to a small city having a very complete equipment for treating a muddy river water with lime, coagulating it with alum, settling, filtering and sterilizing with chlorine. They were having difficulty in obtaining a clear water and the superintendent had used a considerable excess of alum attempting to coagulate this water and thus clarify it. It was found that by increasing the lime charge the amount of alum could be reduced and a much clearer water obtained than before. It is also worth noting that coagulated waters treated with lime show lower bacterial count than those where lime is not used, thus requiring a lower chlorine treatment.

The up to date industrial plant in this city has provided itself with a complete water softening equipment purely as a matter of economy without any coagulant other than the precipitates formed by the reaction between the lime and soda ash with the scale forming salts contained in the water. This applies to plants using raw Missouri River water as well as those using the clarified city water. Nor does this exempt the municipal industries themselves who

*Paper read before the Iowa Section of the American Water Works Association, at Omaha.

have found it to their advantage to install such treatment. From this treatment a surprisingly clear water is obtained which gives little trouble in boilers from the formation of scale and which yields a substantial return on the investment in the efficiency of operation and economy in maintenance of the power plant.

I do not mean to advocate here that filters should not be used, I believe any city is entitled to the best water that can be produced and therefore believe in filtration following coagulation and softening with ample settling basins to clarify it. Such treatment greatly reduces the amount of filtering area required and therefore the initial cost of filters as well as reducing the operating cost.

There are many people who consider softening of a municipal supply an unnecessary refinement but I submit to you that if a water can be furnished with more than 50% of the hardness removed, at a cost of from one to two cents per 1000 gal., that such an operation would pay and be greatly appreciated by a large number of citizens. This method is particularly applicable to city plants where turbid waters are taken from the streams and clarified by coagulation and settling. The necessary softening equipment can be installed on such a plant at a nominal cost and I know of no improvement involving so small an expenditure that would meet with such universal approval in the community.

Cap De La Madeleine Water and Sewer Systems

Old Systems Became Inadequate as Population Increased — Water Supply From Wells and Surface Drainage Collected in Reservoir — Pumping Plant — Details of Materials Used — Cost of Work

By ROMEO MORRISSETTE
Town Engineer.

CAP DE LA MADELEINE, Que., is located East of the St. Maurice river and North of the St. Lawrence in the neighborhood of Three-Rivers, both towns being connected by bridges which span the river St. Maurice, the main industries are shipbuilding and paper manufacturing. Cap de la Madeleine was incorporated in 1918, the area of the town being 4,235 acres of which approximately 700 are the built-up section through which there is now laid complete water and sewer systems. The town is nearly level with the exception of the Northern section which is at the foot of the Laurentian Mountains and is called the Coteau. The population has grown as follows:

Year.	Population.	No. of Houses	Value of New Construction.	Total Municipal Valuation.
1901	900	....	.....	.....
1911	1,464	....	.....	.....
1916	3,322	15	\$35,000	\$1,284,905.00
1917	3,825	10	28,000	1,860,895.00
1918	4,235	25	50,000	2,157,270.00
1919	5,555	75	187,000	4,398,715.00
1920	7,315	149	449,175	5,388,189.00
1921	6,730	40	277,000	6,640,351.04

There are approximately 889 houses, 554 tenements, one paper mill, one shipyard, one saw mill, one foundry, three churches, one college, one convent and five schools in Cap de la Madeleine. The municipal valuation is as follows: Assessable, \$3,440,375.06; non-assessable, \$3,199,975.98.

By a by-law dated March 28, 1917, the parish of Cap de la Madeleine granted a franchise of Alphonse Anbin, of St. Jerome du Lac St. Jean, on the understanding that a water supply and sewer system was built. In the same year a company was organized and was called La Campagnie de l'Acqueduc du Cap de la Madeleine Limitee. The parish had become a town and a company's bonds were guaranteed by the new town; they were issued in 1917 and made payable in 1927 with 6% interest.

Original Water and Sewer Systems

In 1918 a 10-in. main was laid for a length of 4,200 ft. also 7,170 ft. of 8-in. pipe 16,540 ft. of 6-in. pipe, 821 ft. of 4-in. pipe and 3,956 ft. of 2-in. pipe. The total length was 32,689. To which were added 28 gate valves and 47 Ludlow hydrants. All the pipes and over 4 in. in diameter were

class C cast iron pipes and the others were galvanized iron pipes. The sewer system consisted of 1,680 ft. of 20-in. clay pipe used chiefly as collectors from the street mains to the river outlets, 14,966 ft. of 12-in. pipe and 2,200 ft. of 9-in. pipe; the slopes varied from 4% to 0.20%.

A reservoir was built at the top of the hill, 900 ft. from the pumping station and at 60 ft. elevation above. It was a circular type, 86 ft. in diameter at the top and 50 ft. at the bottom, and 10 ft. high. No reinforcement was placed in the bottom but $\frac{3}{4}$ -in. and $\frac{1}{2}$ -in. twisted bars were used in the sides. Two single-stage 4-in. Keystone pumps were installed, 6-in. suction and 4-in. discharge. The water was supplied from a series of artesian wells $2\frac{1}{2}$ in. in diameter spaced 10 ft. centre to centre along the intake pipe. This system has given a good service since. The total number of wells is 37.

In 1918 the built-up section of the town was approximately 200 acres stretched all along the Quebec-Montreal road, a distance of approximately $2\frac{1}{2}$ miles. As soon as the development of the town increased the company was unable to carry further works on its own resources and without additional help from the town. Then came the ques-

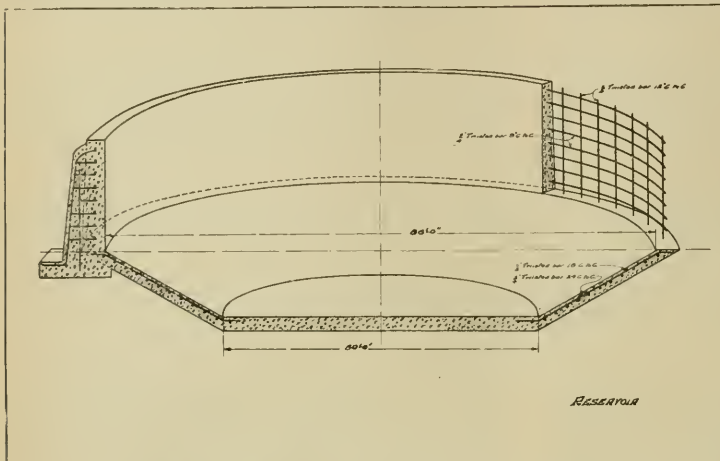


PLAN OF WATER DISTRIBUTION SYSTEM. CAP DE LA MADELEINE

tion of municipalizing the systems. The error committed by the town at the time was that it did not install them itself. The price asked by the company was \$210,000, the town, as payment assuming the company's 6% bonds. A

already assumed by the taxpayers. However, plans were prepared so that any time the town decides to carry out this plan, it will be easy. The plan called for laying 9,045 ft. of 4-in. pipe and 15,275 ft. of 6-in. pipe. Work was started on that branch September 8 and on January 1, 1922, 7,969 ft. of 4-in. pipe and 13,508 ft. of 6-in. pipe were laid. Twenty 6-in.-13 4-in. and one 8-in. Jenkins gate valves were installed. They were supplied by J. B. Loranger, of Three-Rivers, Que. Also 90 plugs, 41 T's, 12 reducers, 4 bends, 33 crosses and 14 sleeves. The cast iron class C pipe was bought from Canada Iron Corporation, Three Rivers, and supplied by J. M. Bellefeuille, Cap de la Madeleine. The price paid was \$67.50 per ton delivered on the site for 6-in. pipe and \$72.50 for the 4-in. pipe.

About 16,601 lbs. of lead were caulked in the 6-in. joints, an average of 13 lbs. per joint, total, 1,277 joints. There were also 6,515 lbs. of lead caulked in 4-in. joints, an average of 9-lbs. per joint; 714 pounds were melted.



SECTIONAL VIEW OF RESERVOIR, SHOWING REINFORCED CONCRETE BUTTRESSES SUPPORTING NEW PART OF STRUCTURE

vote was called from the ratepayers and was favorable to the purchase, which took effect on April 5, 1921.

Extension Approved

The question of extending the system in order to give service to all the taxpayers was the first thing considered and the writer received instructions from the town council to prepare plans and report on the cost of the proposed extension. An estimate was prepared and submitted to the council on May 27, 1921, and adopted. This was approved by the ratepayers and the Provincial Government. On September 1, 1921, work was commenced, and it is now nearly completed.

The first question to be considered was the capability of the springs to supply water and observations and measurements were made from 37 artesian wells and from the surface water. Each well furnished ordinarily 14 gallons of water per minute. The conformation of the land is as follows: 4 ft. of humus, 6 ft. of alluvial sand and a deep stratum of clay. Many of these wells were disconnected recently and replaced by 3-in. wells. In 75% of them water reached naturally a higher level in the well than the water level of the pond into which they are sunk; the balance flowing over freely. This will give an idea of the quantity of water flowing through the soil if we consider that these wells are sunk in a third of an acre. The total discharge for eight hours' pumping was found to be 250,000 gallons. Secondly, the water comes also from springs and is spread over the soil. The quantity of water which may be collected immediately at the surface is in the neighborhood of 3,000 g.p.m. The writer advised the town to control as much land as possible, to plant trees, so that the ground be kept wet with the least chance of evaporation. This was based on the principle that the humus retains two and a half times its volume of water. Many acres were immediately secured.

Extent of New Systems

A general plan was prepared and a 14-in. main contemplated, but as it would have cost about \$221,400 in addition to the \$150,000 estimated for the extension to service alone, this scheme was dropped on account of the small financial resources of the town and the large indebtedness

Analysis of Cost Per Unit

(A) To lay-in 6-in. pipe per standard length.

Wood to melt lead	\$0.128
13 lbs. of lead at 6 1/2 cents	\$0.845
Jute	0.005
Caulking	0.800
Total	\$1.778
Cost per lineal foot	\$0.148

To lay-in 4-in. pipe per standard length.

Wood to melt lead	\$0.089
9 lbs. of lead at 6 1/2 cents	0.575
Jute	0.004
Caulking	0.567
Total	\$1.235
Cost per lineal foot	\$0.103

(B) To direct the work.

Wages of foreman per lineal foot	\$0.0333
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(C) Cost of trenches per foot.

Planking or panneling	\$0.0980
Temporary bridges	0.0103
Excavation	0.3761
Filling in	0.1564
Total	\$0.6408
Cost per unit of length	\$0.7408

(D) Laying-down Clay Pipe.

Dia. of Pipe	Lbs. of oak-um per joint	No. of joints per bag of cement	Cost of labor per joint	Cost of oakum	Cost of concrete	Total cost	Cost per lin. feet.
9 in.	0.14	19	\$0.114	\$0.0098	\$0.0432	\$0.1670	\$0.0557
12 in.	0.21	12	0.171	0.0147	0.0700	0.2557	0.0852
15 in.	0.27	12	0.228	0.0189	0.0700	0.3169	0.1260
18 in.	0.55	9	0.344	0.0385	0.0920	0.4745	0.1890

Number of clay pipe sheets used.

Dia. of Pipe	No. of Sheets Broken	No. of Sheets Used
9 in.	126	4450
12 in.	54	1428
15 in.	35	1424
18 in.	14	1054

Excavating and Filling Trenches

Excavation and filling in of trenches was carried on for a distance of 26,040 ft. The maximum depth excavated



CONCRETE MANHOLE WITH FORMS REMOVED

was 14 ft. and the minimum was 3 ft. 6 in. The average depth to which pipes were laid was 6 ft. 9 in. as per actual measurements on profiles. There were 31,465 cu. yds. of excavated material removed and replaced in the trenches. There were 40,645 hours spent on the job and the total cost amounted to \$13,819. The excavation cost an average of \$0.37608 per lineal foot of trench and the filling in \$0.15637 per lineal foot or a total of 44 cents a cu. yd. The work was done by day labor, men being paid 32½ cents per hour. Two methods of bracing earth in the trench were used, sheet piling and panels and braces placed every 4 ft. centre to centre along the trench. Pile sheeting proved to be the more economical method, principally where soil was alluvial sand which is encountered in great quantities at Cap de la Madeleine; also in the western part of the town where there is water-bearing soil.

The average cost of planking was as follows:

12,230 ft. of studding 3 in. by 4 in.	\$ 520.64
18,019 ft. of 2-in. spruce	759.56
Wages at 2,590 hours	1,285.25

\$2,565.45

The cost per lineal foot of trench being \$0.098.

Manhole Construction

Manholes were built at the intersection of every street. They are 42 in. in diameter inside of circular type, 8 in. thick and made of 1-2-4 concrete. The trouble with the old system was that sand comes in the pipe with the storm water. The manholes in this system are built with the pipes laid flush with the manhole bottom and they are of small size. The sand has no chance to deposit which gives a lot of trouble and costs a great deal in maintaining the system in a good running condition. To obviate this trouble in the new manholes, the pipes enter the manhole 9 in. and sometimes 12 in. over the bottom, depending on the nature of the soil adjacent to the section of the manhole. This will give a chance for the heavy matter in suspension to stay in the manhole and eliminate the chances of decrease in the velocity of the sewer which was computed to furnish at least a velocity of 2 ft. per second when running full. Demountable forms were used for the erection of these. Three of them were built and served for the 37 manholes built during the fall. The covers were furnished by Henri Nobert, Three-Rivers, and supplied by Francis Hankin & Co.,

Montreal. The cost was \$1855.63 including 37,112 hours of labor.

Each man-hole cost \$108.44 which may be summarized as follows: Cast iron cover, \$30.25; Labor, \$50.19; Cement, \$18.00; Sand, \$2.25; Crushed stone, \$7.75; Total, \$108.44. The concrete cost \$22.34 per cu. yd. on an average with forms included. The high cost of the concrete on this job was due to the fact that a small quantity of concrete was mixed by hand at every manhole. The handling of materials and forms was also a big factor in the cost.

Service Pipe Connections

Water supply and sewer service connections were installed on approximately the whole length of the new system. Trenches were excavated at a less depth in the earth and at a time when the earth began to freeze in the fall. For this purpose streets were opened on a length of 4,537 ft. at a mean depth of 5 ft. The excavation and filling in cost 27 cents per lineal foot. The following materials for rock connection were used: ¾-in. galvanized iron pipe, 6-in. clay pipe for sewer, one 6-in. bend, one Mueller curb cock, one Mueller corporation cock and box buried 5 ft. Average length of service pipe laid in was 24 ft. and 6 in. Labor costs per unit, \$5.41; Tools, \$8.72; Materials, \$20.84. As the tools include a tapping machine, etc., which are being retained by the corporation for further work, this item has been deducted from the total cost which makes the cost of each service \$26.25 for clay pipe laid during winter months.

As there was a long stretch of 18-in. clay pipe to be laid through a swamp at a depth varying from 10 to 16 ft. and because many men were unemployed, it was decided to carry this work through the winter months. The results have proved satisfactory as 1,000 ft. have been laid up to January 31, 1922, and the analysis of the cost is as follows: Unit cost per lineal ft. supervision, 0.15; Pipe laying, 0.255; Excavation, 0.905; Total, \$1.310. The filling in was left for the summer months as the earth on the bank was frozen. All the materials were bought by the city. The 18-in. clay pipe cost \$1.40 per foot delivered on site and the 15-in. clay pipe cost 0.965 per ft.

Reservoir Increased in Capacity

The top of the old reservoir built in 1918 by Mr. Arcand was raised 6 ft. As there was no reinforcement in the bottom, the writer was skeptical about adding an overload due



CONCRETE MANHOLE IN DEMOUNTABLE FORMS

to the new mass of concrete. To take care of this buttresses were built 15 ft. centre to centre around the new structure. These buttresses were resting on a rectangular footing 4 ft. by 5 ft. by 2½ ft. Reinforcing rods were connected with the wall and the footing in such a manner that the new structure is completely independent of the old one. The work was started on September 8 last and completed on October 1,

1921. On October 8 the reservoir was filled to its full capacity, 537,330 gallons. The walls of the new structure are 12 in. thick at the top and 15 in. at the bottom. "Pudlo" cement was used as waterproofing in the proportion of four pounds per bag of cement. The reinforcement consisted of $\frac{3}{4}$ -in. twisted bars spaced 12 in. centre to centre crosswise and 8 in. lengthwise. All the work was done by day labor and the concrete mixed by hand. The total cost per cu. yd. was \$19.50, including the forms, labor and materials. An earth embankment was also built afterwards to preserve the reservoir from the frost. This work was also done by



RECONSTRUCTED CONCRETE RESERVOIR—
CAP DE LA MADELEINE

day labor and cost on an average of 30 cents per cu. yd. Cement was supplied by J. B. Loranger and J. M. Bellefeuille, Cap de la Madeleine, lumber by Morin & Freres Ltd., Cap de la Madeleine and "Pudlo" cement by the Spiedman's Agencies, Ltd., Montreal.

Pumping Station

The new pumping station is a brick and reinforced concrete structure. Lumber has been used only in the false roof. Reinforced trusses are 15 in. deep by 12 in. thick. The building is 42 ft. 6 in. long by 20 ft. wide. There will be installed in this building a three-stage automatically balanced centrifugal pump; the intake will be 8 in. and the discharge 6 in. The working pressure at the discharge will be 125 lbs. per sq. in. This pump will be driven by a 150 h.p. electric motor and a 180 h.p. Sterling gasoline engine. A Venturi meter and a pressure gauge register will also be installed.

Hydrants

Thirty more hydrants have been bought and 22 are now in service in addition to the 47 on the old service. They are of the "Ludlow" make with two outlets and a steamer connection. In the old system the hydrants had only the two standard outlets which were not suitable if the municipality decided to buy a fire pump in the future, in which case all the hydrants would have to be changed. Therefore it was decided to proceed immediately to meet future requirements. The price paid for hydrants was \$80.00 each, delivered. They were sold by H. Massicotte & Freres, Ltd., Cap de la Madeleine, Que. They were installed at the unit price, viz., \$18.00 each, the town furnishing all the materials.

Showing the rapid progress that has been made in the development of electricity, J. F. Peters, an engineer attached to the laboratories of the Westinghouse Electric and Manufacturing Co., Pittsburg, Pa., addressing the Hamilton branch of the Engineering Institute of Canada at the Westinghouse auditorium on March 21, stated that it was now possible to transmit power up to 220,000 volts to a distance ranging from 250 to 500 miles. It could be transmitted further even than that, the speaker declared, but the cost was too great to make it of any commercial value over that distance.

SUBMARINE COAL MINING

GREAT technical difficulties have been overcome by Canadian mining engineers in the extraction of coal and iron ore from under the sea, F. W. Gray told the Montreal Branch of the Engineering Institute of Canada, addressing them on April 6, on the subject of submarine coal mining in the Sydney district of Cape Breton.

Mr. Gray gave great credit to the Canadian pioneers of submarine mining, who had made possible still greater developments in the future.

The lecturer referred to the remarkably small number of fatalities that have been caused by inundation of submarine coal mines, a fact which reflected credit on the men responsible for the direction of these operations. Only once in Japan and once in England had the flooding of a submarine coal mine resulted in serious loss of life.

This danger of flooding was the chief obstacle in the engineer's way, in carrying on submarine coal mining. Once the excavation got underneath the bed of the sea, an intimate knowledge of the nature of the sea bottom was essential to safety. Pockets might occur in the sea bed, which if not known might prove disastrous. An intimate knowledge was also necessary of the nature of the strata between the sea bed and the coal, in order to know the extent of the danger of water percolating into the mine, and the steps necessary to guard against it.

The Sydney mines, the speaker said, constituted the largest submarine coal field in operation in the world. Coal was also extracted from below the sea bed at points in Great Britain, Australia, Japan and Chile. Eighty per cent of the Cape Breton coal reserves were under sea, and seventy per cent of those of Nova Scotia were also below the ocean bed. In the case of the Princess Colliery, belonging to the Nova Scotia Steel and Coal Co., at Sydney Mines, coal was being extracted as far as $2\frac{1}{4}$ miles out from the shore. At many other points coal was being worked at distances of one mile or more out from the shore, and at a depth of 1,400 ft. below the bed of the sea.

U. S. GOVERNMENT MOTION PICTURES

IN LINE with its policy of informing the public, especially those who pay the taxes, as to the economies that may be effected in the construction of highways, as well as the proper methods of construction, the United States Government, through the Bureau of Public Roads, Department of Agriculture, has just completed for free distribution and use in motion picture houses as well as at conventions, chautauquas and educational conferences throughout the country, two reels of pictures showing in detail the construction of the various types of asphalt roads. The pictures were exhibited for the first time at the recent American Good Roads Congress in Chicago. The pictures were taken last summer in New York, New Jersey, Pennsylvania and other states under the direction of E. J. Wulff, senior highway engineer, U. S. Bureau of Public Roads, and E. J. Kelly of the Motion Picture Division, United States Department of Agriculture. The pictures were produced particularly for the purpose of showing how the best results may be obtained in asphalt construction. They are loaned to responsible parties free of charge, except for transportation costs. The government pictures offer an interesting and instructive addition to any motion picture program. Each reel is approximately 900 ft. long and about fifteen minutes time is required for its showing.

The sum of \$1,317,508.61 has been paid to the Ontario Provincial Government to date from the grant of \$20,000,000 made by the Dominion Government for good roads. So far the Province of Ontario has not filed for approval under the federal highways act any project for highway construction north of the Severn River. Roads in Northern Ontario were built, and where necessary, maintained by the colonization roads branch of the Ontario government, which is distinct from the Ontario Highways branch.

HIGHWAY ACCOUNTING*

System in Force in Elgin County Highway Department —
Field and Office Reports and Forms Employed—
Every Expense Item Recorded

By G. F. Pince

Road Superintendent Elgin County

WHEN the writer was appointed Road Superintendent of Elgin County we had no regular system of bookkeeping for taking care of our highway accounts. We started out possibly in a crude way; in the first instance each foreman was furnished with a little time book in duplicate. He sent one copy to my office and from that book I copied on to a time sheet the time of every man certified to by the foreman; the other book he kept himself.

Then there was a county road order passed to pay the amount on the paysheet and a cheque for the whole amount was sent to each foreman. Later we adopted the system of sending each man on the highway system an individual cheque.

Various Forms Used

Then we adopted a small pay sheet or weekly report sheet. Form No. 1 of the county highway system is a statement of the travelling expenses of the road superintendent. Form No. 28 is an order for payment on the treasurer. Form No. 2 is an order form that we have always used in the County of Elgin. If supplies are needed for the county I order then and have a copy of that order on the order form which is very convenient to have in the office. We have an ordinary time book which every foreman has to have and in which he keeps his accounts. Form No. 4A is a weekly report of the construction foreman which gives the distribution of all the work he has done. The maintenance form No. 4B is identical with our form. I believe these forms have been recommended by the Department of Highways.

Then we have our order form No. 5A, called the pay list. It contains a duplicate of all time, both construction and maintenance. The order form is folded in four laps and the amount of time the foreman has sent in is placed within the order form, it is then handed to the treasurer with the signature of the county road chairman and myself and on the strength of that the treasurer passes it.

Then we come to the distribution sheet which I always retain in my office. This sheet contains an itemized account of everything, the name of every man who receives a dollar in the county, is placed on that distribution sheet and both the treasurer and I have a duplicate.

On distribution sheet No. 18 we have an exact counterpart of our county road order, therefore it saves some trouble in checking up. For instance we can take our distribution sheets and the county road order, both are identical. I would advise that the distribution sheet be an exact duplicate of the county road order.

Loose Leaf Ledger

Our ledger is also retained in my office and the work is done by my stenographer. This is a loose leaf book with three sheets of different colors, yellow, white and blue. The yellow sheet is used for a general expense account; the white sheet is our construction account and the blue sheet is our maintenance. Each sheet represents one road number. Every road is numbered and is represented by that sheet on the ledger and I can tell exactly every piece of construction work on every road, whether coffer dam, excavating, gravelling, hauling gravel or material of any kind as well as labor, maintenance, dragging of any re-surfacing; every part is specified on that construction sheet in the ledger and can be seen at a glance.

*Paper read at Twentieth Annual Meeting of the Ontario Good Roads Association, March 2.

The towns and villages receive a grant from the County of Elgin equal to the amount they pay in. That money has been expended under my supervision and it is also taken care of in the ledger. I found out at the outset in our county system that we were buying quite a number of tools and different machines. We have three trucks and some gravel outfits but no larger rollers, tractors nor a very heavy nor expensive stock of machinery, but I found it necessary to keep a record of all the machinery and tools we had. I think it is a very important thing for a road superintendent to keep an inventory of all tools and machinery. I have that inventory taken every year. Once I order on my order book a tool or any piece of machinery, I immediately place it on the inventory sheet and charge it up to the special foreman who receives it. From this I can tell in looking over my inventory sheet just where a certain tool should be because we constantly have inquiries and we change these back and forth, and when there is any exchange made I always give one road foreman an order to go and get from the other road foreman whatever he requires in the shape of tools or machinery. That inventory is taken once a year. If a tool is lost I simply remove it and do not have to consider it any further.

Keeping Tool and Gavel Pit Records

In the County of Elgin we have five gravel pits. I keep a separate account of each gravel pit and I have a sheet here for the gravel pit foreman to use. On that sheet is entered the different kinds of work that he will have to do. When it is sent in I immediately take from it and place over on the gravel pit book an exact counterpart of the sheet; therefore, I can compare the cost of stripping one pit against another the other and can tell how much it costs to strip a cord or a yard of gravel. We have a weekly report sheet for the foreman operating the gravel pits and screens. On that sheet he enters the number of men employed and the number of yards or cords of gravel that he has taken out that day or hauled in.

Then we have three trucks and we have a daily report from each truck foreman. The gravel pit foreman's and the truck foreman's sheets must compare as to the number of cords of gravel and so forth that they have removed on that particular day. At the end of the year I can tell our county just what it has cost us for each individual gravel pit.

I do not say it is the duty of the road superintendent to keep up all that office work and look after the roads because that is impossible for him to do, without the assistance of a clerk. You are paying out from \$200,000 and \$600,000 of the ratepayer's money and he wants to know where it goes. We are liable to be criticized but we should be able to protect ourselves and there is no other way of doing that unless we have a strict accounting system.

At the Motor Show at St. John, N.B., recently, an address on "The Value of Good Roads" was delivered by B. M. Hill, chief engineer, Public Works Department, New Brunswick. Mr. Hill outlined the work of the department and urged his hearers to continue their co-operation with provincial authorities for better roads. He explained the necessity of Federal support for the next five years in improving the provincial roads and urged dealers not to encourage purchasers to use any truck heavier than two and a half ton type, as heavier trucks did irreparable damage.

The divisional road engineers of the Nova Scotia Provincial Highways Department held a conference at Halifax recently. Engineers attended from each of the seven divisions in the province. The conference went very thoroughly into the work that had been done, the improvements which may be made upon the experience of the past year, the methods of conducting the work, and the application of their experiences to the programme which is now being laid out for the coming season.

THE RELATION OF CITY PLANNING AND ZONING TO THE SELECTION OF TYPE OF PAVEMENT*

Describes City Maps Prepared at Baltimore — Division of Cities Into Zones — Kind of Pavement in Zone Determined by Traffic

By Jefferson C. Grinnalds

Secretary, Zoning Commission, Baltimore, Md.

CITY Planning is primarily a problem of transportation. Its aim is to provide adequate and convenient arteries for traffic from any part of a town to any other part. Therefore the selection of the type of pavement depends on what sort of service the streets may be called upon to carry, as well as on what will be the volume or density of that traffic. Zoning aims to direct the orderly and logical growth of a city. It prescribes the use to be made of the lands and buildings in different parts of the town, as well as the bulk of the buildings. Therefore the selection of the type of pavement depends also on the use of property because the use will determine the kind of traffic, that is, whether it will be heavy commercial of a local nature, heavy through commercial traffic, light or mixed through traffic or local light pleasure traffic.

Retrospective

Cities used to be planned merely by laying out on paper a lot and street scheme by a land owner or surveyor and the latter probably staked the lines and corners on the ground. The original town sites were comparatively small in area. The situation was probably chosen on the shore of navigable water, at the intersection of two important turnpike roads or later at a promising railroad junction. In early days in the United States the street layout was made by those who were not presumed to have any special skill in design of street systems beyond the knowledge possessed by a surveyor or real estate developer. It is doubtful if any conception of the present day duties of highways could have been experienced then. Converging toward the towns were at first paths through field or forest. Then came wheeled vehicles making tracks over the trails.

The writer has been informed that post roads were the next step to be followed by what were known as turnpikes. Then as the turnpike companies sprang up and developed, not only were rights-of-way acquired, but they were surfaced, repaired and kept in more or less passable condition. Here was the beginning of the selection of a type of pavement ostensibly suitable to the kind and amount of traffic. The turnpikes were to be the forerunner of the major street plan of today. They were generally radial with respect to the centre of the town and the then purlieus. As the town expanded, it tended to grow outward on all radials except where expansion was impossible or impracticable due to topographic conditions or to some natural barrier. The old radial roads were pushed farther out and stretched to other important towns or centres by fairly direct routes. They had fair grades, because there had to be a maximum gradient beyond which it was not possible for horse drawn vehicles to ascend. When traffic had increased and an income for maintenance was assured by collection of tolls, paving in a crude form followed. Crushed stone or gravel was spread over the surface to be worn down compactly by the traffic. John Loudon Macadam and Thomas Telford, the famous Scotch engineers, designed their respective types of pavement and they came to be the best paving practice.

Modern Pavements an Improvement

Paving and city planning have both advanced within the last generation to a high degree of efficiency. In the matter of paving there is a long list of various types of pavement from which to select the material to be laid on any particular roadway. The Macadam and Telford paving of so long ago are even still in use and are appropriate pavements for certain kinds of traffic. The tendency, however,

is to select a water-proof paving material, if possible. Oiled macadam and tar macadam have come into use. Bituminous concrete, bitulithic, sheet asphalt, wood blocks, scoria blocks, asphalt block, vitrified brick, granite block and concrete roadways are all later types of pavement from which the engineer may select that most suitable for any particular roadway which he contemplates paving. Since city planning has reached the present advanced stage, we endeavor to select roadways scientifically in the city which may be expected to become the future heavy traffic streets; the arterial street system of the city. The selection of this major street plan is one of the first steps, after certain basic surveys have been made. It is well here to suggest the proper kind of a survey on which to work out a city plan.

From the experience of the city of Baltimore it has been found that a topographic map on the scale of 200 ft. to one inch, showing contours with five-foot intervals, is a practical map to work on. A map has been prepared to show the present location of industries in the city of Baltimore. There has been super-imposed upon the original industrial location map the tentative arterial street plan which is now proposed for this city, together with a population distribution compiled and tabulated from the census of 1920. It is possible to see at once from this map where the industrial areas are and which streets serve those areas; also where the residential part of the town is located. Since each dot represents 100 people, the map shows roadways which are intended to serve these residential areas, local residential streets not being on this map. It is obvious that there are many radial streets which are at present main traffic streets and, in fact, have been main traffic streets for a long period of years. In almost every case they are coincident with the old main radial turnpikes. There have been some slight changes, of course, in their alignment, in their width and grades. Some of them may even be further widened when traffic demands it.

Before selecting all of these streets as main traffic streets, traffic counts had to be made, the traffic congestion studied, traffic density determined, etc. In other words, it is necessary for the city planner to compute, as accurately as possible, what will be the demands upon a street in a generation or two hence, so that he may plan the street of sufficient width to accommodate the load which it may be expected to carry. It is essential to give thought to the kind of traffic which may predominate on any street under study. For instance, the streets which serve the water front property, those which lead to the heavy manufacturing centres, industrial areas and many of the radials and cross town streets may be expected to carry hauling of the heaviest kind. From study of the map and conditions observed in the field, it is evident that certain streets will carry principally light weight vehicles and not heavy loads. The roadways which will be expected to carry the heaviest loads and large numbers of them, no doubt should be paved with a heavy, durable material of high tractivity on a thick base which is laid on a firm, well-rolled sub-grade. The grades, too, will have their bearing upon the kind of paving material. The writer observes that many heavy haulage highways are paved with sheet asphalt, but that would certainly not be the kind of pavement to be laid on a street having a four or five percent grade and over. Granite block with cement or bituminous filler or hillside vitrified brick might be very appropriate for steep grades. It is not always possible for the city planner to avoid grades of over four or five percent on main traffic streets, but since they must exist, the most suitable pavement should be chosen for them.

Zoning — Planning for the Future

Within the last decade there has grown out of city planning investigation a branch of city planning known as zoning. By it cities are divided into certain districts in which are permitted certain uses of the land and buildings. The heights of the buildings for each separate district are regulated suitable for their prescribed use and the percentage of the area of the lot which they may occupy is limited. Height and area restriction, sometimes known as "occupan-

*Paper read at the City Paving Conference, Philadelphia, Oct. 22, 1921.

cy" are often called by an equivalent designation, such as volume or bulk. Before a zone plan is drawn an accurate survey of all the existing conditions within the city limits is necessary. There must be made a map which shows by a color scheme the use of every parcel of land and every building in the city divided into classes, of course. For example, a color denotes all the property devoted to single family residence use; another color denotes two-family residence use; another denotes property devoted to residence and occupied by three or more families; another color stands for business of a retail type; another color for wholesale business, warehouses and light manufacturing use; other colors denote industrial areas, park areas, cemeteries, etc. A second map must be prepared showing the heights of all the existing buildings in the city, classified by a color scheme. A third map is necessary to show the percentage of area of the lot which is covered by every building. The last of the basic data maps preliminary to drawing a zoning ordinance must show land values usually determined by classifying the assessed land value per front foot.

What Will Zoning Accomplish?

When a zoning ordinance has been in effect for a generation or two, definite results will be noticeable in a city where such regulation is effective. The residential areas will not be invaded by inappropriate business or industrial developments, but will show an orderly growth somewhat uniform, where the people will dwell in the quiet enjoyment of their homes undisturbed by the noisy intrusion of heavy traffic. The business area will be compact within the central part of town and it will reach out, too, along the fronts of the main arterial streets. The retail shop and the office building will not have next door to them factories which emit smoke, gas, fumes, odors, dust and excessive noise. The industries will be grouped where they have adequate rail or water transportation facilities, where they will not be hampered by the restrictive regulation incident to residential property and their sites will not be cut up by useless streets. This last mentioned kind of use will be in locations where investment may be considered safe, where there is room for expansion, where they can enjoy all possible encouragement to grow and to perform their function of increasing the city's commercial greatness.

Zoning Determines Kind of Pavement

What has zoning to do with the selection of types of pavement? It will determine for a long period of years what kind of development may be expected in any part of the city. The paving engineer can refer to the zone plan and the written ordinance. He will know with a reasonable degree of certainty that a street which leads up to an industrial zone is to carry heavy loads in numbers commensurate with the area of that district. From the city plan and the topographical maps, he can determine the grades and width of roadway. Comprehensive city planning studies which include attention to every engineering feature, to every public service structure under ground, on the surface or overhead, will give him the kind of information which he needs. In fact, everything that may have any bearing whatever as far as the city planner can determine, has been mapped and considered in drawing the official city plan.

Another map, for instance, will show the present park system of the city. It is a fact that bordering on our present parks can be found all kinds of use, including residential, retail business, light manufacturing and so-called nuisance industries. The last three are evidently inappropriate uses to make of park front property. So it is hoped by zoning to prescribe as far as possible, residence use for park front lands, in order that the greatest enjoyment and largest return in recreation may be had by the people, secured by parks adjacent to their dwellings or at least nearby. The pavements round about the parks may then be suitable types for through traffic streets intended to carry principally pleasure vehicles and local residential streets. On streets of this nature smooth dustless pavements are suitable that may be laid on heavier grades than would be suitable for

industrial streets. The very qualities which are so adapted to residential streets make them inappropriate for heavy haulage highways; one, for example, slipperiness on smooth streets, especially in wet weather.

Railroad and Water-front Facilities

Any city plan must consider railroad terminals, freight yards and rights-of-way for two reasons. The first is that they must have direct routes to every part of the city. Second, they must not be hampered by too many streets cutting into them and making unnecessary grade crossings. The grade crossing nuisance must be emphasized. Every comprehensive city plan must consider the absolute elimination of every grade crossing on through traffic streets. On the streets leading up to, over, under or through railroad properties, all have their particular kind of traffic. Therefore, the type of pavement must be suitable for the kind of use. It must be of sufficient width; it must have proper material to withstand heavy iron-tired vehicles, as well as the ever increasing motor truck traffic.

The water-front must be served by properly situated water-front streets at suitable distances from the shore line and approximately parallel with it, as also it must have ready access to every other part of town. It is necessary to consider that the streets encircling the water-front would ordinarily carry a belt line railroad, probably municipally owned. Heavy paving material on sufficient foundation is required for the duty of these kinds of streets.

Paving Engineers Welcome City Plan

The city paving engineer certainly should welcome a city plan which is scientifically designed to suit the particular needs of every individual part of the city and of the city considered as a whole. The street plan and the zone plan should be worked out simultaneously and co-operatively. Then it will be known what the streets are to serve, what use may be expected of the property bordering on the streets or at their termini. Population distribution and industrial distribution as anticipated by the zoning plan will give a fair estimate of the amount of traffic which a street may be expected to carry within some definite period of years. It is to be hoped that a city plan and a zone plan will guide the paving engineer so that his streets will give the best services, that his moneys will be expended most judiciously, with reference to a scientific study, that the cost of maintenance will be at a minimum and that tax rates and bond issues may be lower; but if there is a fixed sum available for paving, that he will get more mileage by the added efficiency and economy that might be studied.

FREIGHT TONNAGE TO MILEAGE ON CANADIAN RAILWAYS

AT THE freight equalization hearing before the Railway Commission at Ottawa, statements showing density of freight traffic to mileage were filed by T. Marshall, of the Toronto Board of Trade. The freight tonnage and mileage by provinces from Oct. 1920 to June 1921 inclusive of all Canadian railways were as follows: Maritime Provinces, mileage 3,704, freight tons 6,009,677; Quebec, miles 4,877, tons 12,040,777; Ontario, miles 10,988, tons 32,486,435; Manitoba, miles 4,193, tons 3,452,257; Saskatchewan, miles 6,145, tons 4,313,709; Alberta, miles 4,354, tons 5,795,383; British Columbia, miles 4,287, tons 3,048,588. The total mileage was 38,544 and total tonnage 67,146,766.

The western provinces, with 49.2 per cent. of the total mileage had 24.75 per cent. of the total tonnage, Mr. Marshall's statement showed, eastern provinces with 50.8 per cent. mileage provided 75.25 per cent. tonnage.

British Columbia with 11.1 per cent of mileage provided 4.60 per cent of the tonnage, Mr. Marshall stated, and the Provinces with 9.6 per cent of the total mileage provided, 8.9 per cent of the tonnage. Ontario with 2.86 per cent of mileage provided 48.4 per cent of freight revenue tonnage.

Engineer's Library

LAND DRAINAGE

Reviewed by
Douglas L. McLean
Chief Engineer.

Manitoba Drainage Commission, Winnipeg.

LAND DRAINAGE—By W. L. Powers, M.S., Chief of Soils, Oregon Agricultural College and Experiment Station; Secretary Oregon State Drainage Association 1915-1920 and T. A. Teeter, B.S., Professor of Drainage and Irrigation Engineering, Oregon Agricultural College. First edition, 263 pages, 5 1/4 in. by 8 in. Cloth. Published by John Wiley & Sons, Inc., New York.

This book is one of the Wiley Agricultural Engineering Series edited by J. B. Davidson, Professor of Agricultural Engineering, Iowa State College. It is primarily a text book for students in agricultural engineering, but will also be useful to the student of general agriculture, to the practical farmer as well as the owner of wet, overflowed, marsh, swamp or alkaline land.

The list of references dealing with each division of the subject of Land Drainage, would alone make it worthy of a place in every drainage engineer's library, but in addition there is considerable new data presented in simple form in the text. Much of the original data deals with conditions found in Oregon, but the local material is chosen so as not to restrict its useful application to other areas.

This work is well prepared for use as a text book on land drainage. The subject has been developed largely as one in applied soil-physics, but is arranged in simple form and is divided into three parts, viz:

1. Field Drainage.
2. District Drainage.
3. Special Drainage Problems.

A series of questions are included covering the points dealt with in each chapter which will help the reader to crystallize into a clear-cut thought, the ideas presented on each phase of the subject. Clear diagrams and a most fortunate selection of illustrations assist materially in explaining the subject matter. The illustrations are also well chosen to show the advantages which follow land drainage when applied to the reclamation of arid or wet lands.

This work comes at an opportune time, when the United States Government is considering an appropriation of \$370,000,000 to be expended for the reclamation of arid, swamp and cut-over lands, and when a survey of conditions in Western Canada shows that before any great increased population can be secured in a large number of areas, considerable drainage work will have to be undertaken.

Considered from all angles, the authors, while presenting a book dealing with the fundamentals of land drainage, have at the same time added a valuable contribution to the work on this phase of agriculture and engineering.

MECHANICAL WORLD YEAR BOOK, 1922. Messrs. Emmott & Co., Ltd., of Manchester, have issued the Mechanical World year book which has now reached its 35th year of publication. It is filled with information that will be of interest to mechanical engineers everywhere. The present edition is larger than its predecessor by twenty pages and contains some new sections, such as that on pipes and tubes. A most complete buyers' guide is included which is printed in French, Russian, and Spanish languages and will be of great value indeed to people in the countries named, who are anxious to get in touch with British Manufacturers of all kinds of mechanical equipment. The hand book contains 268 pages, is bound in cloth, and sells for 2/6.

A STUDY OF THE EFFECT OF MOISTURE CONTENT UPON THE EXPANSION AND CONTRACTION OF PLAIN AND REINFORCED CONCRETE—By Torata Matsumoto. Bulletin 126 of the Engineering Experiment Station, University of Illinois, Urbana, Ill. Paper; 6 by 9 in.; pp. 29. Illustrated.

TRUE NET SECTIONS OF RIVETED TENSION MEMBERS—By C. R. Young, Associate Professor of Structural Engineering, University of Toronto. Section No. 5, Bulletin No. 2, School of Engineering Research, Faculty of Applied Science and Engineering, University of Toronto. Paper; 6 by 9 in.; pp. 12; illustrated.

OBSERVATIONS ON RAILROAD CONSTRUCTION AND RAILROAD BRIDGES—By Dr. J. A. L. Wadell, Consulting Engineer, New York City. Prepared for and published by the Chinese Railway Association. Paper; 5 1/2 by 8 1/2 in.; pp. 34. Text of a memorandum prepared for the Chinese Railway Association based upon an address delivered before that body. In it are discussed such matters as Effect of Curvatures and Gradients on Traffic, Improvements, Rolling Stock, Bridges versus Tunnels, Best Kind of Bridges for China, Bridge Approaches, Specifications and Contracts, and many other matters of interest to railway and bridge engineers.

STATEMENT RESPECTING FINDINGS AND OTHER STATEMENTS CONTAINED IN THE MAJORITY REPORT OF THE COMMISSION APPOINTED TO ENQUIRE INTO THE SUBJECT OF HYDRO-ELECTRIC RAILWAYS IN ONTARIO. Observations on the Report by Sir Adam Beck, Chairman, Hydro-Electric Power Commission of Ontario. Paper; 7 by 10 in.; pp. 43; Map.

This brochure contains criticisms of the majority report of the Sutherland Commission with respect to many contentious matters pertaining to Hydro-radials. In it an effort is made to show that the conclusions of the commission were unjust and unwarranted.

ST. LAWRENCE PROJECT IN ABEYANCE

IT IS generally believed that the St. Lawrence Power and Navigation scheme will be held up for an indefinite period. It is understood that the Canadian Government while cordially in favor of the project, does not wish to bring it up in parliament at the present time owing to the prevailing financial conditions. As far as the United States is concerned, it is understood that President Harding has decided that a reciprocity treaty with Canada should precede any St. Lawrence waterway legislation by congress.

BUSINESS OUTLOOK IMPROVES

IT IS reported from Hamilton, Ont., that the outlook for business has improved considerably and that a more optimistic feeling prevails in manufacturing circles. The Dominion Sheet Metal Products Co. is now turning out about 75 tons of galvanized steel sheets daily and orders are being received from all parts of Canada. The Hamilton Bridge Works Ltd. have received orders for five new bridges for the T. & N. O. Railway for its extensions in the James Bay division. This order amounts to approximately \$175,000 and has resulted in additional men being re-employed and the east end plant resuming operations. The company has also received orders for the new grandstands at Scott Park, which amount to about \$25,000.

The Alberta Government contemplates appointing a chief commissioner for the new Highways Commission. A highly capable man is required and it is understood that the appointment will be made as soon as a suitable candidate is found.

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MODIFICATIONS IN REINFORCED CONCRETE SPECIFICATIONS

WITH a committee of the Canadian Engineering Standards Association working on the preparation of a specification for concrete and reinforced concrete, attention is being directed in this country to the modifications proposed in the Joint Committee report. While the Canadian specification will no doubt have an individuality all its own, it cannot help but be influenced to a considerable extent by the prolonged and valuable labors of the Joint Committee.

The discussion which has arisen on this report during the few months since its release indicates that there are many contentious matters brought to the fore by it. Last December a two-day discussion occurred before the American Society of Civil Engineers in New York on the proposed specification, and a similar discussion took place at the recent annual meeting of the American Concrete Institute in Cleveland. The Committee which framed the progress report did not regard it as a final document but asked for criticism and suggestions, and these they have received in full measure.

The most criticized clause in the whole document is that referring to the methods of fixing the proportions for the concrete. Three suggested trial clauses covering this matter are framed; the first one providing that the proportions shall be fixed by the engineer from cylinder tests of the concrete, the second that the proportions are to be left entirely to the contractor who must furnish a concrete of a desired strength, and the third stipulating that the proportions shall be determined from a table of the Abrams' type appended to the specification. Quite naturally con-

tractors have generally opposed the second type of clause on the ground that the responsibility for forecasting the appropriate proportions should rest with the engineer who is presumably an expert in these matters. They point out that there is a considerable variation in the 28-day cylinder tests for materials that appear to be similar, and that if the suitability of the concrete is to be determined by such a test, cements giving high initial strength would invariably be used. Such cements, state the contractors, often give a concrete which ultimately is not so strong as that produced by a cement giving a low initial strength. Some construction interests also fear that the first clause suggested would also be onerous to the contractor in that it, in effect, merely transfers the testing from the contractor to the engineer. They allege that the 28-day test would often result in the condemnation of a concrete which would eventually be very satisfactory, and that no doubt many pieces of work have been constructed of concrete that would have been condemned had 28-day cylinder tests been made.

Other clauses on which the commercial interests have taken issue with the framers of the Joint Committee report are those debarring integral waterproofing and those fixing the allowable stress on rail-steel bars at 16,000 lb. per sq. in.

Objection has also been raised by the contractors' committees in New York and Philadelphia on the ground that buildings constructed under the Joint Committee tentative specification would cost more than buildings constructed under the ruling specifications in the larger cities of the United States. For example, it has been calculated that the cost of the steel and the concrete in a reinforced concrete flat slab building designed to the proposed specification would cost 11% more than for such a building designed in accordance with the New York Building Code, and that the cost would be 8% greater than the average cost under eight representative codes in the larger American cities. For a beam and girder building, however, the cost would appear to be some 10% less than the average cost of buildings constructed under these eight specifications. Naturally those who specialize in flat slab construction express opposition to the proposed regulations. It is pointed out, however, that the additional cost arises principally from the revised column specification which is very conservative as compared with similar provisions now in force. This clause, it will be remembered, takes into account the shrinkage of concrete during setting, the initial stress of the steel induced by this shrinkage and the flow of the concrete under load. Undoubtedly allowance for these various effects cause more expensive columns than have heretofore been used and the construction interests are not pleased at the prospect of telling owners that columns in buildings which they have now to erect must be heavier than have been used when many acres of buildings that have been entirely satisfactory have already been built to a much bolder specification.

It is anticipated that in the twelve months or more that may be devoted to the Joint Committee report a great deal of thorough discussion will be given to these and related matters. The facts brought out by such debate will no doubt serve as valuable suggestions to the Canadian Engineering Standards Committee now engaged in the onerous task of framing a representative specification for concrete and reinforced concrete applicable to this country.

FUEL HAZARD STILL EXISTS

ONCE more labor disruption in the coal fields of the United States brings to the attention of Canadians the desirability of a strong policy in the matter of fuel supply for this country. A year ago a Committee of the House of Commons conducted an investigation of the future fuel supply of Canada, obtaining extensive information on the subject and making certain recommendations to the House. So far as is known, no fundamental change in the manner of dealing with this situation has been brought about. Perhaps the improved conditions pertaining to the supply of

fuel which came about with the commercial depression have beguiled us into inaction and it may need a still more powerful stimulus than ordinary strikes to result in effective action.

The facts of the situation have often been stated, but do not appear to have sunk home as yet. At the investigation mentioned it was shown that in the acute fuel area extending from Montreal to a point just inside the boundary between Manitoba and Saskatchewan 94½% of the coal consumption for the year 1920, was reported. For the whole of Canada the importation of coal for the year 1920 was 20,816,000 tons, or 59% of the total consumption. Added to this there was a very considerable importation of coke amounting in value to almost five million dollars.

While it may be impracticable under present transportation conditions to relieve the situation by the use of coal from Nova Scotia or the Prairie Provinces there is a real remedy available in the acute fuel area through the further development of water power. Considering the average coal consumption required for power plants, big and little throughout the country, probably nine tons of coal per horse power year would be required. If the fuel saving for the Chippawa power development alone be computed there would be, assuming the entire 600,000 h.p. to be installed, an annual saving of over five million tons of coal, or approximately 25% of the importation into this country. If, added to this, the possible savings from other water powers in the acute fuel area be considered, it is seen that there is a real remedy for the coal situation and that a much to be desired commercial independence in the matter of fuel could be attained by the greater development of water power.

OBITUARIES

CHARLES E. FIELD, a veteran railway contractor, died at Brockville, Ont., on April 10, aged 86. Mr. Field was for years engaged in railway construction work in Western Canada in partnership with the late H. B. Abbott, and also built the first line of railway across the Island of Montreal.

CHARLES S. BOONE, the well-known dredging contractor, died in Toronto on April 11, after a long illness. Mr. Boone was born in Oakville, Ont., 67 years ago and at the age of 27 started in business as a dredging contractor in Toronto, later becoming president of the C. S. Boone Dredging & Construction Co.

EUGENE T. LUCEY, a prominent contractor of Yorkton, Sask., died at Fort Qu'Appelle. Mr. Lucey was born at Heming, Minn., and when a young man located in the South Quill Plains District. Later he became a contractor and built several bridges in the Province of Saskatchewan. He moved to Canora in 1914, but left in 1918 to reside in Yorkton.

PERSONALS

J. W. THOMPSON has been appointed road superintendent for Wainfleet Township.

ED. HAMEL has been recommended by the Public Works Committee for the position of assistant city engineer of Quebec.

BRIG.-GEN. W. M. B. KING, of Kingston, Ont., will be transferred to London as general officer commanding Military District No. 1. He was a contractor in civil life, and saw active service in the South African and European Wars. He has been in command at Kingston about two years.

ROBERT O. SWEZEY, well-known as a consulting engineer on forestry, hydro-electric and pulp and paper problems, has become a member of the recently organized investment banking firm of Newman, Swezey & Co., Montreal. Mr. Swezey, though giving considerable time to the new financial concern, will continue the practice of his profession.

R. E. CLEATON, president of Cleaton Co. (Canada) Ltd., and of Inventions, Ltd., Montreal, has returned to Canada to resume active charge of affairs of these companies, after having spent the last three years in England in connection with business interest which he has in that country. Inventions, Ltd., are the sales agents for the Rawlplug Co. of Canada, Ltd. The Cleaton Co. (Canada), Ltd., are manufacturers' agents, representing a number of prominent American and English lines of fuel-economy equipment.

GEORGE DEWAR MACDOUGALL, who was appointed last summer as chief engineer of the British Empire Steel Corporation, was born on September 26, 1873, at St. Peters, Cape Breton, N.S. He was educated in the Common School of Oxford, Cumberland County, N.S.; Pictou Academy, Pictou, N.S.; Dalhousie College, Halifax, N.S.; and McGill University, Montreal, where he graduated in 1895 with the degree of B.A.Sc. (with honors) in mechanical engineering. After graduation Mr.

MacDougall entered the employ of the Robb Engineering Co., Amherst, N.S. In November, 1895, he entered the employ of Geo. F. Blake Mfg. Co., East Cambridge, Mass., where he spent three years in the shop and engineering department. After a year with the Fore River Ship & Engine Co., Weymouth, Mass., as chief draughtsman on marine machinery, he joined the staff of the Edison Electric Illuminating Co., Boston, Mass., and in September, 1899, was placed in charge of power house design and erection. From February,

1900, to November, 1921, Mr. MacDougall was with the Dominion Iron & Steel Co. at Wabana, Nfld., as master mechanic and assistant manager of ore mines. He resigned from this position in order to become assistant chief engineer of the Lackawanna Steel Co., at Buffalo, N.Y., later becoming mechanical superintendent of that company. In January, 1904, Mr. MacDougall accepted appointment as mechanical superintendent of the Dominion Iron & Steel Co. at Sydney, N.S. Two years later he was appointed chief engineer of that company. From April, 1909, to November, 1910, he was superintendent of construction for the Canada Iron Corporation, Midland, Ont. In January, 1911, he rejoined the Dominion Iron & Steel Co. as mechanical superintendent, and in October, 1916, was appointed assistant general superintendent in charge of engineering and mechanical departments. In October, 1918, the Nova Scotia Steel & Coal Co., Ltd., obtained Mr. MacDougall's services as general superintendent, which position he retained until his appointment as chief engineer of the British Empire Steel Corporation upon the merger of the Dominion and Scotia companies. Mr. MacDougall is president of the Nova Scotia Mining Society, past president of the Nova Scotia Accident Prevention Association, vice-president for Nova Scotia of the Canadian Institute of Mining and Metallurgy, and a member of the Engineering Institute of Canada, the American Iron and Steel Institute, and the West of Scotland Iron and Steel Institute.



The name of the Barber Asphalt Paving Co. has been changed to the Barber Asphalt Co. Announcement is made by A. W. Sewell, president of the company, that the change involves no alteration in the organization or obligations of the company.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Toronto, Ont., construction of pavements, curbings and sidewalks	Apr. 19	Apr. 11
Delia, Alta., erection of schoolhouse	Apr. 20	Apr. 4
Halifax, N.S., highway construction	Apr. 20, 22, 24 & 26	Apr. 4
York Tp., construction of watermains	Apr. 22	Apr. 11
Toronto, Ont., erection of church and rectory	Apr. 24	Apr. 11
Prince Edward Island, Province of, grading and concrete structures	Apr. 28	Apr. 11
Prince Edward Island, Province of, road materials	Apr. 28	Apr. 11
Pembroke, Ont., erection of hospital	May 9	Apr. 11
Ontario, Province of, various work on Provincial highways	May 11	Apr. 11

BRIDGES, ROADS AND STREETS

Alberta, Province of.—The appropriations for road work total \$1,520,000 this year, and \$600,000 will be available in addition for bridges. The Highway Department will definitely attempt to qualify for the Federal road grant Sections of main roads in different parts of Alberta will thus be entered for the Dominion funds, and it is expected that a substantial amount will be earned under this scheme.

Halifax, N. S.—Tenders, addressed to the Provincial Highways Board, will be received until noon, April 29, for the construction of three roads. (See official adv.)

Halifax, N. S.—A petition from the residents of Cape Sable Island, requesting the construction of a bridge to connect the island with the mainland, was presented to the house of assembly by Hon. E. H. Armstrong, minister of Public Works and Mines.

Hamilton, Ont.—Estimates prepared by Road Superintendent T. R. Allison of Wentworth County call for an expenditure of \$206,027 on road work this year.

Hamilton, Ont.—Reeve Ray, of East Flamboro, will request Wentworth County Council to take over the road surveyed through the Bolton farm, and which is intended as a link between the Waterdown road and the Provincial highway. Estimated cost of work, \$50,000.

Kingsion, Ont.—City Council voted \$75,073 for construction of pavements. It is probable that the city will spend upwards of \$150,000 on pavements this year. City Engineer, Howard S. Dick.

Lindsay, Ont.—Victoria County Good Roads Board plans an expenditure of \$175,000 this year. New machinery will be purchased. Road Superintendent, E. L. Miles, Lindsay.

London, Ont.—H. A. Brazier, city engineer, states that the supply of Portland cement and broken stone required by the city during the current year will be purchased on the open market.

London, Ont.—Contract has been awarded to the United States Asphalt Refining Co., New York, for supply of refined asphalt and road oil for the current year. Tenders received were as follows: Asphalt delivered in packages,

Imperial Oil Ltd., Toronto, \$29.30; Texas Co., New York, \$27.34; Barber Asphalt Co., Philadelphia, \$31.32; United States Asphalt Refining Co., New York, \$23.38; Sun Co. of Canada, Toronto, \$23.95. Asphalt delivered in tank cars—Imperial, \$29.30; Texas, \$19.37; Barber, \$27.47; U. S. Asphalt, \$19.06; Sun, \$19.80. Light asphaltic road oil (140,000 Imp. gal.)—Imperial 11c; Texas, 9.6c; Johnson Oil Refining Co., Detroit, 11c; Sun, 9.5c; Crescent Oil Co., Hamilton, 11.5c; U. S. Asphalt, 8.05c. Medium asphaltic oil (30,000 Imp. gal.)—Imperial, 11c; Texas, 8.39c; Johnson, 11.5c; Sun, 9.5c; Crescent, 11.5c; U. S. Asphalt, 8.05c. All prices are in Canadian funds, f.o.b. London.

Montreal, Que.—Tenders, addressed to the civic executive committee, for the supply of about 4,000 tons of inorganic stone dust, will be opened at the City hall at noon, April 20.

Niagara Falls, Ont.—Contract awarded to the Dufferin Construction Co., Toronto, to build 6 miles of stone road from Green's Corner to the Welland canal, and work has started.

Oakville, Ont.—Pavements will be constructed on the following streets: Allen, Chisholm, Church and Brant. Clerk, Percy A. Bath.

Ontario, Province of.—Construction work will be resumed on the provincial highways in the vicinity of Hamilton, within the next few weeks, it was announced recently by Hon. F. C. Biggs, Minister of Public Works. Contracts for the Brantford highway, the Hamilton-Winona road and the Binkley subway have been let and the work will be gone on with as soon as the ground is in a workable condition.

Ottawa, Ont.—A large delegation waited upon Premier King and other Government ministers on April 11 to urge the importance of the construction of a bridge between the city of Montreal and the south shore of the St. Lawrence River. The delegation asked the Government to vote \$50,000 to pay the expenses of a commission of engineers to take soundings and report on the feasibility of the project. If this is done, the Government will be asked to authorize the Montreal Board of Harbor Commissioners to issue bonds to cover the cost of construction, the Government guaranteeing these bonds. Premier King in reply stated that all the arguments put forward would receive the most careful consideration of the Government.

Pembroke, Ont.—A movement is on foot for linking up the thirty miles of road lying between Pembroke and Mattawa, as yet unfinished, of the highway running between Mattawa and North Temiskaming.

Queenston Heights, Ont.—Tenders will be received by John H. Jackson, Superintendent, Queen Victoria Niagara Falls Park Commissioners, Niagara Falls, Ont., until 12 o'clock noon, May 24, for the sub-grading and construction of 4,100 ft. of macadam roadway, 24 ft. wide. (See official adv.)

St. Thomas, Ont.—Tenders will be received by W. C. Miller, city engineer, until noon, April 28, for the construction of pavements. (See official adv.)

South Vancouver, B.C.—A delegation of property owners from the district bounded by 25th and 34th avenues and Knight Road and Fraser Street, headed by Mr. Hall, presented to the council a petition asking that a by-law for paving the roads through this area, extending about eight miles, be submitted to the said owners. Estimated cost, \$123,000.

Stratford, Ont.—Contract awarded to W. L. Malcolm Co., Kingston, for \$57,000, for the construction of approximately 32,000 sq. yds. of concrete base for pavement and

approximately 22,000 ft. of combined concrete curb and gutter.

Toronto, Ont.—Advisory Commercial Committee of Board of Education decided to donate to the city a piece of land south of Dewson St., on condition that the City Council straighten Dewson St. and construct a pavement and sidewalks.

Toronto, Ont.—City Council intends to construct concrete sidewalks on Clendenan Ave., Coxwell Ave., Evelyn Ave., Glendonwyne Road and Glenholme Drive at a total estimated cost of \$16,280; also concrete curbing on Fawcett Ave.

Toronto, Ont.—Plans of the proposed new Gerrard St. bridge over the Don were submitted to the Public Works Department at Ottawa for approval. Tenders will be called for as soon as the approval of the Department is obtained. Estimated cost, \$750,000.

Toronto, Ont.—Toronto & York Roads Commission has awarded contract to the Warren Bituminous Paving Co. of Ontario, Ltd., for two miles of work at Sharon; to R. H. Blackwell, of Toronto, a bridge at Richmond Hill, and to Ben Bees, of Newmarket a bridge at Mount Albert, Ont. E. A. James, Engineer.

Unionville, Ont.—Contract for grading the Markham-Whitchurch townline has been awarded to William Faiza, 43 Scott St., Toronto, at 29¢ per cu. yd. The Engineers are James, Proctor & Redfern, Ltd., of Toronto.

Victoria, B.C.—Extension of the Island Highway, from Forbes Landing, was urged upon the Provincial executive council by a delegation from Sayward district. The matter will be considered by the Department of Public Works. Estimated cost of the 40-mile extension, \$250,000.

Wainfleet Tp., Ont.—Council passed by-law appropriating \$9,350 for roads. Road Supt., J. W. Thompson.

Welland, Ont.—Tenders will be received until May 1, addressed to Robert Cooper, Clerk of Welland County, for the construction of 15½ miles of 9-ft. waterbound macadam road, 1¼ miles of 16-ft. water-bound macadam and 2 miles of bituminous penetration road. Plans and specifications may be seen at the County Clerk's office at Welland.

West Hill, Ont.—The Ontario Bridge Co., Ltd., Toronto, who have the contract for the Highland Creek bridge on the provincial highway which is being built here on the Kingston road section of the provincial highway, have the work well under way, excavation being practically finished and material on the ground ready for concreting the foundations.

WATER, SEWAGE AND REFUSE

Halifax, N.S.—City Engineer F. W. W. Doane recommended sewer extension on South St., between Queen and South Park Streets, at a cost of \$7,200. Works Committee approved report and sent it on to City Council.

Kitchener, Ont.—Six-in. water mains will be laid on Louisa St., Dane St. and Crescent St. Mains will also be laid on Victoria and Mount Hope Streets. Superintendent of Water Commission, Mr. Pequegnat.

Montreal, Que.—City Council adopted a resolution favoring the construction of three incinerators.

Montreal, Que.—The construction of three incinerators will be considered by the Public Works Commission. President, Ald. Carmel.

Niagara Falls, Ont.—Tenders were received until April 13 by C. M. Border, architect, for the erection of a pump house for the Water Commission.

Niagara Falls, Ont.—Water Works Commission approved plans prepared by Architect Border for the proposed new "booster" pumphouse for the South end. Tenders will be called.

Ottawa, Ont.—City Council intends to construct 9-in. tile pipe sewers in Harmer Ave. and Lyndale Ave. City Clerk, N. H. Lett.

Petrolia, Ont.—Tenders addressed to John McHattie, Secretary, Water Commission, will be received until 5 p.m.,

May 1, for the supply and construction of steel reservoir, foundation and pump. (See official adv.)

Seaforth, Ont.—Contract has been awarded for the reservoir, pump-house and dwelling to B. & N. Planing Mill Co., Milverton, Ont., and the contract for the elevated tank to the Hunter Bridge Co., Kincardine Ont., James, Proctor & Redfern, Ltd., 36 Toronto St. Toronto, are the Engineers.

Sydney, N.S.—City Council plans installation of several sections of sewer.

Toronto, Ont.—Works Committee approved of sewers being laid on Courtleigh Boulevard.

Toronto, Ont.—City Council intends to construct a sewer in Mount Pleasant Road, from Heath St. to St. Clair Ave., at a cost of \$5,450.

Toronto, Ont.—Ald. Burgess introduced a motion that the Works Commissioner bring in a recommendation to pave Annette St., from Runnymede to Jane St.

York Tp., Ont.—Water mains will be laid on Coxwell Ave.

York Tp., Ont.—Engineer R. O. Wynne-Roberts has requested the Toronto Waterworks Commission to report on the feasibility of supplying the east side of the township with 100,000 gallons of water per day. The allotment is 25,000 gallons, and this has been overdrawn to 50,000, but 100,000 gallons are required.

LIGHT, HEAT AND POWER

Calgary, Alta.—Tenders will be received at the office of J. M. Miller, city clerk, until 1 p.m., April 27, for the supply of an electric arc welding outfit.

Kingston, Ont.—Scheme is under way for supply of Hydro power to Ernesttown, Kingston and Pittsburg Townships.

Mimico, Ont.—Town Council passed by-law authorizing the raising of \$25,000 for Hydro extension purposes.

Port Credit, Ont.—The Council passed by-law authorizing the issue of debentures for \$20,000 for Hydro extension purposes. It is proposed to extend the present system within the town limits.

Windsor, Ont.—Transportation Committee of City Council recommended that the Hydro-Electric Power Commission of Ontario be asked to construct an auxiliary steam plant here.

Winnipeg, Man.—Tenders will be received at the office April 17, for the supply of labor and material required for the construction of conduit runs and manholes. Specifications may be obtained at the office of the Hydro-Electric Department, 55 Princess St.

RAILWAYS

Galt, Ont.—A new joint station for the Grand River and Lake Erie and Northern Railway is to be built on Main St. this summer.

Kitchener, Ont.—Contract for laying of King St. east extension of Kitchener and Waterloo street railway has been awarded to the Standard Paving Co.

London, Ont.—A movement is on foot for the construction of a Union Station. Address Mayor Wilson.

Ottawa, Ont.—A bill providing extension of time for the construction of branch railway lines in Saskatchewan and Alberta by the C.P.R. was before the railway committee of the House recently and was ordered reported. It provides for the construction of three branch lines: from the Manitou Lake branch northwest through Lloydminster to Whitford Lake, Alberta; from near Asquith to Cloan, Sask.; from near Rosetown, Sask., to a point on the Pheasant Hills branch near Keppell.

Regina, Sask.—Delegates have been named by the Boards of Trade of Prince Albert, Melfort and The Pas to go to Ottawa to urge the completion of the Hudson Bay Railway.

Toronto, Ont.—Work will start shortly by the Toronto

Transportation Commission of the construction of a double-track line from Sunnyside to the Humber.

Toronto, Ont.—The Transportation Commission, it is expected, will commence the season's construction work toward the end of this week. The first section of track to be reconstructed will be that portion of King St., between York and Church Streets.

Victoria, B.C.—Mr. Cameron, Vancouver Island representative of the C.N.R., has been instructed to submit a report to Ottawa on the proposed 10-mile extension of the Island railway, to connect the line with the James Logging Co., on Cowichan Lake. Premier Oliver is urging an early start on the work.

Windsor, Ont.—Newhall Construction Co., formerly known as the Marble & Palmer Co., has been awarded contract for the greater portion of the program of construction work which the Michigan Central Railway will undertake this year.

FACTORIES AND LARGE BUILDINGS

Acton, Ont.—Erection of a \$100,000 tannery warehouse is planned by Beardmore & Co. of Toronto.

Bathurst, N.B.—The opera house was complete destroyed by fire. Loss, \$50,000.

Belleville, Ont.—American Optical Co. of South Bridge, Mass., has decided to erect a Canadian plant in this city.

Belleville, Ont.—City Council has authorized Board of Education to erect a school in Coleman Ward to be known as "King George School," at a cost of \$120,000.

Birch Cliff Heights, Ont.—Tenders for the erection of a Public School, including excavation, masonry, stonework, structural steel, steel stairs, steel sash, roofing and sheet metal work, carpentry, electric wiring, lath and plastering, painting and glazing, terrazzo work, plumbing, heating and ventilating, will be received by Burden & Gouinlock & Carter, Architects, 101 King St. West, Toronto, until 5 p.m., Wednesday, April 19. Plans and specifications may be obtained at the office of the architects, or information at the Township Offices.

Brigewater, N.S.—Tenders, addressed to James A. Curll, town clerk, for the erection of a Fire Hall, and also a separate tender for the plumbing and heating, will be received until 4 o'clock p.m., Monday, May 8.

Calgary, Alta.—Contract for construction of home for mental defectives awarded to Thomas, Jamieson & McKenzie, of this city, for \$165,604.

Calgary, Ont.—Separate School Board sold an issue of debentures amounting to \$20,000 for the construction of an addition to St. Anne's School in East Calgary.

Edmonton, Alta.—Contract for erection of \$20,000 building for James McDougall awarded to the Permanent Construction Co.

Edmonton, Alta.—By-law will likely be submitted to the ratepayers providing for the construction of a new market building at a cost of \$16,000.

Edmonton, Alta.—A three-storey block will be erected on 101st St. by Willard Kitchen at a cost of \$60,000. Architects, G. H. MacDonald and H. A. Magoon.

Edmonton, Alta.—Authority for a large extension to the Miseriordia Hospital is being asked, and it is expected that work will commence shortly. It is proposed to build an extension north of the present structure at an estimated cost of approximately \$250,000.

Edmonton, Alta.—Library Board has requested city officials to submit by-law to the ratepayers providing \$37,500 as additional funds for a new library building. City has already received a grant of \$37,500 from the Carnegie Foundation. Chairman, Mr. Barclay.

Edmonton, Alta.—A permit has been taken out for a garage to be built at the corner of 100th St. and 102nd Ave. by the Empire Loan Co., of Winnipeg, the estimated cost being \$15,000. It will be occupied by the Lines garage, Lees, Bigler & Moore are the contractors.

Fredericton, N.B.—Contract for erection of factory here on the Chestnut Canoe Co., Ltd., awarded to Thomas S. Miles, Devon, N.B.

Fredericton, N.B.—Tenders will be received until 12 o'clock noon, April 15, for the moving and repairing of a building at the York County Municipal Home, according to specifications to be seen at the Secretary-Treasurer's office, Fredericton; Town Clerk's office, Devon; and Fred Seymour's store, Nashwaaksis.

Fort William, Ont.—Tenders addressed to R. E. Mason, architect, Fort William, will be received until 5 o'clock, Thursday, April 27, for construction of Crawford Ave. Public School.

Grande Prairie, Alta.—Prominent Chicago financiers are considering the construction of an oil refinery here. Address John Gorman, city engineer.

Guelph, Ont.—A new building is to be erected to replace the present Brooklyn Sunday School building. Cost, \$20,000.

Guelph, Ont.—Contract awarded to the Yates Construction Co., of Hamilton, for construction of Collegiate Institute and Technical School, the contract price being \$262,524. This price is to cover all the construction with the exception of plumbing, heating and ventilating, the contract for which was awarded to W. G. Edge & Co., of Ottawa, for \$53,925. These prices do not include a swimming pool, but this may be included later. Building will be of reinforced concrete.

Hamilton, Ont.—Contract awarded to W. H. Cooper for the construction of a Masonic Temple. Estimated cost, \$300,000.

Hamilton, Ont.—Contract for construction of three more sections to grandstand in Scott Park awarded to Hamilton Bridge Works Co. by Parks Board. Estimated cost, \$16,500.

Hamilton, Ont.—The erection of a hotel on the Dynes property at Hamilton Beach is under construction. Address Beach Commissioners Col. J. J. Grafton and James Crooks.

Hamilton, Ont.—Contract let to W. H. Copper for the erection of an addition to "The Towers," the former Tuckett residence, which was recently acquired by the Ancient and Accepted Scottish Rite. The addition will cost \$150,000.

Kenora, Ont.—Board of Education plans erection of 4-room school at cost of \$25,000.

Lachine, Que.—Board of Railway Commissioners has approved plans for a new railway station to be erected by the city. Work will be started shortly.

Lindsay, Ont.—Sharpe & Horner, of Toronto, have been appointed architects for the proposed additions and alterations to the Collegiate Institute. Estimated cost, \$60,000.

London, Ont.—The Board of Education's expansion program, approved at the March meeting, calls for the erection of an 8-room school on the Dakin and Price St. property; purchase of sites for a public school in West London, for another in East London and for a collegiate in the East End; also improvements and additions to the Technical School equipment.

Mitchell, Ont.—Erection of new High School is projected.

Montreal, Que.—Church of the Sacred Heart, destroyed by fire, will be rebuilt, work to start shortly.

Montreal, Que.—Contract awarded to Anglin-Norcross Ltd., for construction of medical building on southwest corner of Guy and Sherbrooke Streets. Building will be ten stories high.

Montreal, Que.—Tenders will be called this week by the Protestant Board of School Commissioners for the erection of a school in Notre Dame de Grace. Estimated cost, \$350,000. Architect, Kenneth C. Rea.

Montreal, Que.—Catholic School Commission has purchased site for school and sisters' residence in the Parish of St. Anselme, on Forsyth St. Estimated cost of school, \$156,000. The residence will cost \$45,000.

Moose Jaw, Sask.—Work will commence within the

next few weeks on the construction of the new building for the Dominion Express Co.

Newmarket, Ont.—Newmarket Arena Co., Ltd., will build a rink on Cedar St., at a cost of \$30,000. Plans have been prepared by O. E. Tench.

New Westminster, B.C.—Plans are under way for rebuilding the Brunette sawmills, destroyed by fire.

North Bay, Ont.—Plans for the erection of a police station are being prepared. Clerk, William N. Snyder.

Oakville, Ont.—Erection of a new school on site of Central School is projected. Chairman of School Board, William Busby.

Oshawa, Ont.—Tenders, addressed to Dr. F. L. Henry, 28 King St. East., Oshawa, Ont., will be received until noon, Monday, April 24, for the construction of a Maternity Wing to the Oshawa Hospital. Work consists of concrete, masonry, carpentry, plumbing, heating and wiring. Plans and specifications may be seen at the office of the Hospital Treasurer Bank of Montreal, Oshawa.

Ottawa, Ont.—The new Ottawa Arena will cost, it is expected, somewhere in the neighborhood of \$200,000.

Ottawa, Ont.—St. Luke's Church, at Somerset and Bell Streets, will be torn down this spring and replaced by a large brick church. Architect, C. M. Dewit.

Owen Sound, Ont.—Preliminary plans for the proposed addition to the Collegiate Institute have been completed.

Peterboro, Ont.—By-law granting fixed assessment of \$20,000 to the Western Clock Co. was passed by ratepayers. Work on the new plant on Hunter St. east will be started at once.

Quebec, Que.—Building permit for \$55,000 has been issued to the Catholic School Commission.

Quebec, Que.—Public Works Committee let contract to J. H. Fontaine for construction of refrigerator in St. Sauveur, for \$10,160.

Quebec, Que.—Permit issued to the Canadian Royal Engineers for rebuilding that part of the Government Arsenal which was damaged by fire recently. Cost, \$24,000.

Quebec, Que.—Plans for construction of 4-storey building in rear of City Hall to contain three safety vaults, were submitted to Public Works Committee by City Engineer Baillarge. Estimated cost, between \$25,000 and \$30,000.

Quebec, Que.—Redemptorist Fathers will build a rectory on Grande Allee, and members of St. Patrick's church will erect a building connecting the rectory with the church and construct a sidewalk along the parish property on De Salaberry St. Address, Col. J. S. O'Meara.

Richard's Landing, Ont.—Practically the whole business section of the village was destroyed by fire, including the post office.

Rimouski, Que.—Tenders for the construction of the Rimouski Agricultural School will be called shortly by the Provincial Department of Agriculture.

St. Mary's, Ont.—Hurlbut Shoe Co. plans addition to plant.

St. Thomas, Ont.—The installation of an entirely new heating and ventilation system at Myrtle street public school at an estimated cost of between \$6,000 and \$7,000, was recommended to the internal management committee of the Board of Education by Donald Stewart, consulting heating engineer, of Windsor and Hamilton.

Saskatoon, Sask.—Contract for the new chemistry building at the University of Saskatchewan will be awarded to Bennett & White, of Calgary, at a price around \$100,000.

Saskatoon, Sask.—Following contracts have been awarded in connection with the erection of new Chemistry Building at University of Saskatchewan: General contract, Bennett & White Construction Co., Calgary, Alta., \$427,652; plumbing and heating, Green & Litster, Winnipeg, \$153,700; and electrical contract, Wheaton Electric Co., Saskatoon, \$20,930.

Simcoe, Ont.—Board of Education requested Town Council to issue debentures to provide \$100,000 for 6-room addition to south school and erection of 8-room school in north end.

Sharon, Ont.—Division of school section No. 3, of East Gwillimbury, Township and erection of a new school on Cemetery Hill, is proposed.

Straford, Ont.—Separate School Board awarded contract to John Hayman & Son, Ltd., of London, for construction of school, for \$62,300.

Straford, Ont.—Work is to be commenced shortly on the erection of a large Sunday School building in connection with Memorial Baptist Church. The plans call for the erection of a thoroughly modern brick building, two stories high.

Toronto, Ont.—Plans and specifications are to be prepared and tenders called for erection of Moose Hall on Heintzman Ave. Sec.-Treas., Bro. R. M. Ferguson.

Toronto, Ont.—Construction program of the Separate School Board already approved for this year calls for an expenditure of \$356,000. Other work may be approved shortly.

Toronto, Ont.—Bulk and separate tenders will be received until 5 p.m., April 21, for the erection of St. Saviour's Parish Hall, Swanwick Ave. Plans and specifications may be obtained from Mr. Loffree, 99 Main St.

Toronto, Ont.—It is stated that plans have been drawn for a 10-storey building for the Robert Reford Steamship Co. on property near Wellington and Bay streets. This will probably involve the use of between 400 and 500 tons of structural steel.

Toronto, Ont.—Tenders, addressed to W. W. Pearce, Business Administrator and Secretary-Treasurer, Board of Education, 155 College St., will be received until Wednesday, May 3, for the following trades for Riverdale Branch Technical School, Greenwood Ave.:

(1) Masonry, including concrete work; (2) cut stone; (3) structural steel; (4) ornamental iron; (5) steel sash; (6) plastering; (7) roofing and sheet metal work; (8) carpentry work; (9) marble and tile and terrazzo; (10) mastic flooring; (11) painting and glazing; (12) plumbing; (13) heating and ventilating; (14) heat regulation; (15) Refrigeration; (16) hydraulic ash hoist; (17) dumb waiter; (18) electric wiring; (19) local phones; (20) programme and time clocks.

Specifications may be seen at the office of the Architect of the Board, 155 College St.

Vauxhall, Alta.—Tenders will be received by the Board of Trustees of School District No. 4053, at the office of Harry V. Rounds, Sec.-Treas., Vauxhall, until noon, May 1, for the erection of a school building.

Victoria, B.C.—Contract let to Luney Bros., Sayward Building, for alteration on the Vernon Hotel block for the F. W. Woolworth Company's new store. Work was started. Cost, \$60,000.

Weston, Ont.—By-law providing for the raising of \$115,000 for additions to High School will be submitted to ratepayers.

Windsor, Ont.—Windsor Council, Knights of Columbus, plan erection of club house. Architect, John R. Boyde, Windsor.

Windsor, Ont.—Board of Park Commissioners awarded general contract for construction of clubhouse in Wigle Park to the John V. Gray Construction Co. The cost will be \$8,500. R. Paddon & Co. secured the plumbing contract at \$1,160.

MISCELLANEOUS

British Columbia, Province of.—Railway Committee of the House of Commons, Ottawa, approved an extension of time to the Burrard Inlet Tunnel and Bridge Co. in which to carry out the work authorized in 1910. The company was incorporated for the purpose of constructing a tunnel under the first narrows of Burrard Inlet and a bridge over the second narrows for foot passengers, steam and electric railways. The bill granting the extension provides that the work must be completed in five years and that 15% of the amount of the capital stock must be expended on the work within two years.

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Mechanical Stresses in Transmission Lines

Chart Developed Applicable for any Ice and Wind Loading and Any Temperature for Horizontal Spans of 100 to 1500 ft. and Supports at Same or Different Elevations — Chart Only for Copper Wire

By E. MAERKER

Fargo Engineering Co., Jackson, Mich.

ENGINEERS dealing with transmission line problems have long felt the need of a simple comprehensive chart applying to all cases which are liable to come up. Transmission line calculations pertaining to mechanical stresses are very lengthy and cumbersome and require constant checking in order to avoid errors.

Many tables and diagrams have been published by various writers, usually based on a maximum loading of the wire of $\frac{1}{2}$ in. of ice at zero deg. F., combined with a wind pressure of 8 lb. per sq. ft. of projected area. The chart devised by the writer and presented herewith as Fig. 3. may be used for any ice and wind loading at any temperature, the horizontal distance between supports ranging from 100 ft. to 1500 ft., and the supports being either level or at different elevations. The chart can be used only for hard-drawn copper wire, this being the only restriction. With a different material such as aluminum, steel, etc., all

physical constants will change and a new set of curves will have to be drawn. Similar charts can, of course, be constructed for other materials.

While taking account of practically all variations, the writer has endeavored to make the construction of this chart as simple as possible, so that it may be read by the average trained engineer. The

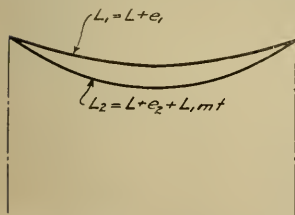


Fig. 1—Changes in Length of Wire Due to Tension and Temperature

construction is based on the nomographic type, and the various scales are so arranged as to minimize inaccuracies due to reading.

The chart enables the engineer to string the wire with a certain tension at stringing temperature in order to prevent the tension from exceeding the allowable limit at a low temperature, and, on the other hand, to keep the sag or deflection in the wire within the required limits at a high temperature.

Notation

- Let a = area of the wire in square inches,
 W_w = weight per foot of bare wire in lb.,
 W_1 and W_2 = resultant forces acting on the wire in lb. per ft. of wire,
 T_1 and T_2 = tension in wire in lb.,
 P_1 = tension in wire in lb. per square inch,
 l = horizontal distance between supports in ft.,
 d = vertical distance between supports in ft.,
 L_1 and L_2 = length of wire in ft.,

h_1 and h_2 = sag or deflection of wire from midpoint of line joining supports to wire at midspan in ft.,
 e_1 and e_2 = elongation caused by tension in wire,
 m = .0000096, coefficient of linear expansion,
 E = 16,000,000 lb. per sq. inch, modulus of elasticity
 t = temperature in degrees, F.

Assume a wire suspended between two rigid supports, as in Fig. 1. Evidently this wire undergoes a change in length with a change in temperature or a change in loading. The effect of a temperature change is always partly counterbalanced by the effect of the resulting change in tension. A rise in temperature will stretch the wire and increase the sag. This increased sag in turn will lessen the tension and cause a shortening in the length, provided this takes place within the elastic limit of the wire. The algebraic sum of these changes will be the actual change in the length of the wire. A fall in temperature will cause the wire to shorten and decrease the sag, which in turn will increase the tension and elongate the wire. An increase in loading will result in an increase in tension and elongation in the wire and vice versa.

Development of Equations

When a wire be cut to length L .

When suspended this length will change to L_1 due to the stretch in the wire. Furthermore, let a change of temperature and loading take place and elongate the wire to length L_2 . (See Fig. 1). From L_1 we have to subtract e_1 , the elastic change, to get the original length L , and from L_2 we subtract $mL_2 t$, and e_2 , the temperature change and the elastic change to obtain L , or $L = L_1 - e_1 = L_2 - mL_2 t - e_2$, and transposing,

$$L_1 (1 + mt) - e_1 = L_2 - e_2$$

To evaluate e_1 and e_2 , we employ the fundamental formula, Modulus of elasticity, E = Unit stress / unit strain

$$= (T_1/a \div e_1/L_1) = (T_2/a \div e_2/L_2)$$

The above equation then becomes,

$$L_1 (1 + mt - T_1/aE) = L_2 (1 - T_2/aE) \dots \dots \dots (1)$$

According to the parabolic law, a line drawn tangent to the curve and parallel to line AB, in Fig. 2, will meet the curve at point D midway between supports. The lowest point of the wire is at a distance x from point D. The vertical component $T \tan v$ at point D must be equal to Wx , or

$$x = T \tan v / W = Td / Wl$$

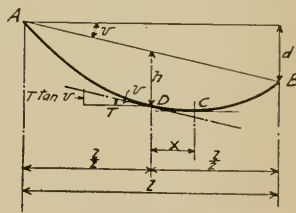


Fig. 2—Mechanical Characteristics of Stressed Wire

By taking moments A, and simplifying it is found that

$$h = Wl^2/8T$$

which is equivalent to the maximum sag for level supports.

The length of wire for level supports is expressed as follows,

$$L = 1 + Wl^2/24 T^2$$

The length of the wire in Fig. 2 is made up of segments AC and BC, which when added together give as the total length of wire

$$L = 1 + (Wl^2/6T^2) \left\{ (1/2 + x)^2 + (1/2 - x)^2 \right\}$$

Substituting for x, the value Td/Wl from above and simplifying,

$$L = \left\{ 8 (1^2 + d^2/2) / 3l \right\} \left\{ \frac{3}{8} + h^2/(1^2 + d^2/2) \right\}$$

As seen from this equation, the length of a wire for sup-

ports at different elevations differs from the length for level supports by the term $d^2/2l$.

Substituting the value of L with proper subscripts in Eq. (1), we have

$$h_1^2 E / (1^2 + d^2/2) - \left\{ \frac{3}{8} + h_1^2 / (1^2 + d^2/2) \right\} (T_1/a - E m t) = h_2^2 E / 1^2 + d^2/2 - \left\{ \frac{3}{8} + h_2^2 / (1^2 + d^2/2) \right\} T_2/a \dots (2)$$

Equation (2) is a general equation and the various constants for the particular material of which the wire is composed may be substituted in it and a chart drawn up.

Applying the formula to hard-drawn copper wire, $E = 16,000,000$ and $m = 0.0000096$. The term T_1/a in Eq. (2) represents the tension per square inch and will be denoted by P_1 . For copper, the weight per foot of bare wire $W = 3.864 a$, or $a = W/3.864$, and since $T_2 = W_2 l^2/8h_2$, we may

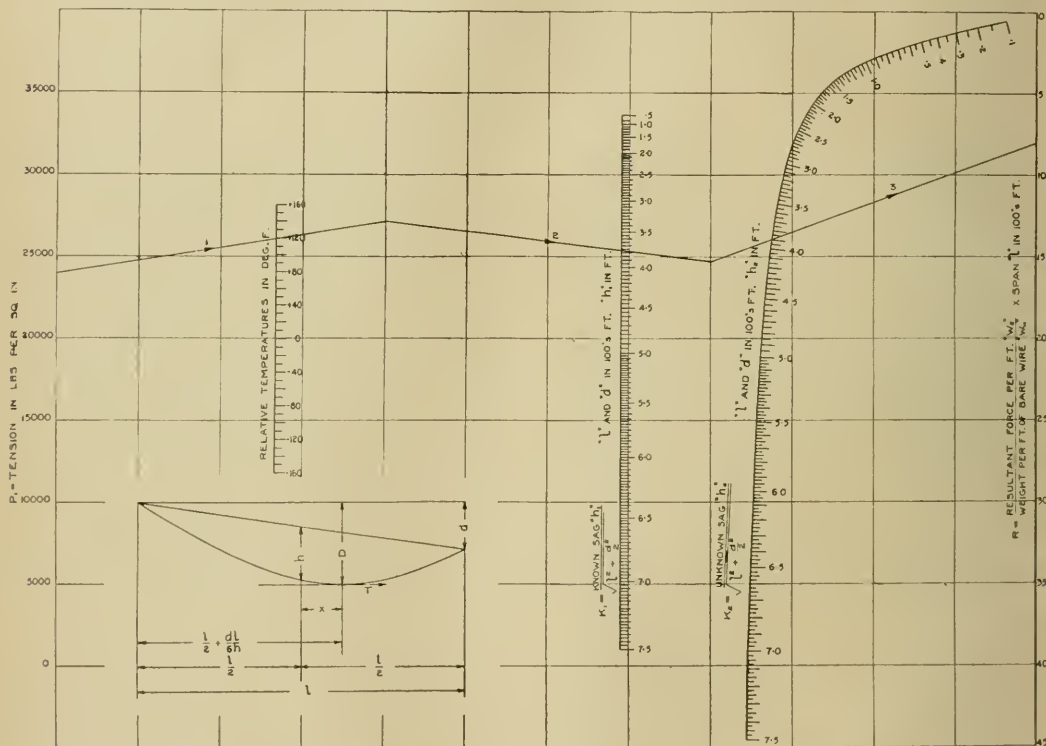


FIG. 3—TENSION AND DEFLECTION CHART for Hard Drawn Copper Wire, Stranded or Solid, of Any Size, for Any Temperature Range and Any Ice and Wind Loading. Spans up to 1500 Ft. with Supports Level or at Different Elevations.

Modulus of Elasticity = 16,000,000; Coefficient of Linear Expansion = 0.0000096

$W =$ Weight per foot of bare wire.

Subscripts "1" refer to given quantities.

Subscripts "2" refer to quantities to be found, except in case of W_2 , which must be known

- * l and d are in hundreds of feet in the formulae.
- $P_1 = T_1/a$
- $h_1 = W_1 l^2/8T_1$
- * $K_1 = h_1/(1^2 + d^2/2)$
- * $R = W_1 l/W_2$
- * $h_2 = K_2 (1^2 + d^2/2)^{1/2}$
- $T_2 = W_2 l^2/8h_2$
- $x_2 = dl/8h_2$
- $D_2 = (d + 4h_2)^2/16h_2$

Example

Given . 250,000 c.m. hard-drawn copper wire stressed up to 4,725 lb. at zero deg. F. with 8 lb. of wind and $1/2$ in. of ice. Area of wire, $a = 0.19635$ sq. in. Weight of bare wire $W = 0.762$ lb. $W_1 = 1.788$ lb. $W_2 = 0.762$ lb.

Span $l = 800$ ft. Difference of elevations between supports, $d = 100$ ft.

Required: (1) Maximum vertical sag at + 120 deg. F. with no ice or no wind load; (2) Tension in wire; (3) Location of lowest point of wire.

Procedure: Compute P_1 , K_1 and R from above formulae and follow guide lines from 1 to 3. From K_1 , so found, compute h_1 , T_1 , x_1 and D_1 .

Results: (1) $K_1 = 3.90$. $h_1 = 3.90 (1^2 + 1/4)^{1/2} = 31.25$ ft.

(2) $T_2 = (0.762 \times 800^2)/8 \times 31.25 = 1,950$ lb.

(3) $x_1 = (100 \times 800)/8 \times 31.25 = 320$ ft.

$D_1 = (100 + 4 \times 31.25)^2/16 \times 31.25 = 101.25$ ft.

substitute for T_2/a in Eq. (2). If we also replace h_2/l by its approximate value $h_2/(l^2 + d^2/2)^{1/2}$, and we express l and d in hundreds of feet, and P in thousands of pounds per sq. in., we have after simplifying,

$$1,600 K_1^2 - (3570 + K_1^2) (P_1 - 0.1536t) \div 10 \\ = 1,600 K_1^2 - (3,750 + K_1^2) \times 0.483R/K_1, \dots\dots\dots (3)$$

where K_1 and K_2 represent $h_1/(l^2 + d^2/2)^{1/2}$ and $h_2/(l^2 + d^2/2)^{1/2}$ respectively and $R = W_1 l/W_2$

For the case where the supports are on the level K_1 and K_2 will be h_1/l and h_2/l respectively. Eq. (3) also applies if the pull on the horizontal support is in a horizontal direction or acting upward.

The chart shown in Fig. 3 was plotted directly from Eq. (3), only three operations being necessary starting from the left of the chart and working toward the right. One example with explanations is given on chart. The lowest point of the wire is most always at no ice and no wind loading, and for supports at different elevations this point is at a horizontal distance $x = Td/Wl$ from the centre of the span toward the lower support and the vertical distance $D = (d + 4h)^2/16h$ from the top support.

The chart shown in Fig. 4 gives the tension and sag for a 250,000-c.m. copper wire for different conditions of load-

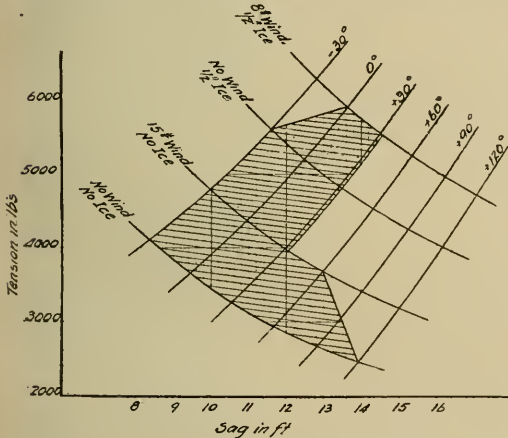


FIG. 4—SAG AND TENSION CHART for 250,000 C.M. Hard-Drawn Copper Wire and 600-Ft. Span, Based on Maximum Tension of 5,900 Lb. at Zero F., 8-Lb. Wind and 1/2 In. Ice

ing and for a range in temperature from -30 deg. to +120 deg. F., the span being 600 ft. The maximum tension was based on 5,900 lb. at 0 deg. F. with 1/2 in. of ice and 8 lb. wind. The values were found from the chart of Fig. 3 and arranged on a tension and sag scale as shown. The boundary of the shaded area represents the limitation of tension and sag. It was assumed here that a wind pressure of 8 lb. per sq. ft. of ice-covered wire is not liable to occur at -30 deg. F., accounting for the upper corner of the diagram being chipped off. The ice limit curve is seen to run at 32 deg. F. until the curve of no ice is reached. From here the boundary line runs to 60 deg. F. and 15 lb. per sq. ft. of wind pressure and then connects to no ice and no wind curve at +120 deg. F. While a maximum tension of 5,900 lb. at 0 deg. F. was specified, it will be well to investigate the tension at the minimum temperature, especially if the span is short.

The chart of Fig. 5 shows the same wire with same conditions of loading for a 200-ft. span, but the tension at -30 deg. F. exceeds 5,900 lb. For this span the tension of 5,900 lb. should be based on 1/2 in. of ice with no wind at a temperature of -30 deg. F.

In transmission line work a uniform span between towers cannot always be adhered to on account of highway crossings, railroads, rivers, etc. For this reason a chart comprising various spans will be found very useful. Furthermore since the charts of Figs. 4 and 5 present a complete picture of the behavior of the wire under different

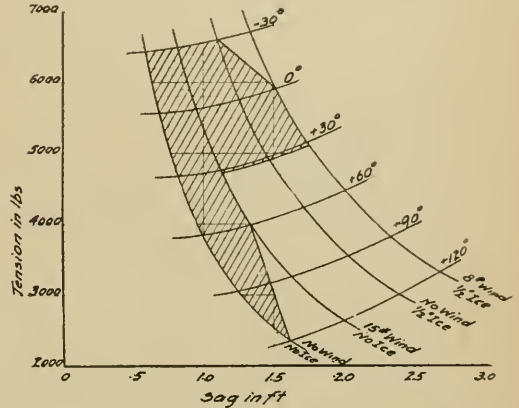


FIG. 5—SAG AND TENSION CHART for 250,000 C.M. Hard-Drawn Copper Wire and 200 Ft. Span, Based on Tension of 5,900 at Zero F., 8-Lb. Wind and 1/2 In. Ice

loadings, a chart with no ice and no wind loading will be more useful for stringing purpose, including, of course, the usual range of temperature.

Fig. 6 gives a chart which has been drawn up for the same wire and for spans ranging from 200 ft. to 1,000 ft., all based on 5,900 lb. tension at 0 deg. F. with 8 lb. of wind and 1/2 in. of ice. This chart brings out a very important point, especially for lines where post type insulators are used and where the supports are rigid.

Coupling a 600-ft. span with a 200-ft. span, it is seen

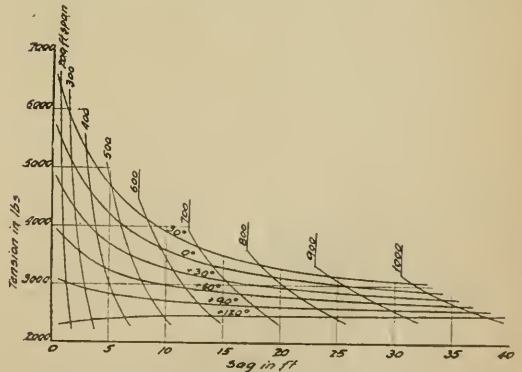


FIG. 6—CHART FOR STRINGING WIRE—250,000 C.M. Hard-Drawn Copper Wire for Spans 200 to 1,000 Ft. Based on Tension of 5,900 Lb. at Zero F., 8-Lb. Wind Pressure and 1/2 In. of Ice

that at 120 deg. F. the tension for the 600-ft. is 2,465 lb. and for the 200-ft. span 2,350 lb., a difference of 115 lb. in favor of the longer span. At -30 deg. F., the 600-ft. span has a tension of 4,110 lb. and the 200-ft. span a tension of 6,400 lb., a difference of 2,290 lb. in favor of the shorter span. These 2,290 lb. represent a dead pull along the line

and too great a stress on the insulator and the supporting structure, especially if this particular tower should happen to be at an angle, in which case the insulator would have to bear the stress due to the angle in addition to the stress of 2,290 lb. as mentioned above.

It will be noticed here that although a maximum of

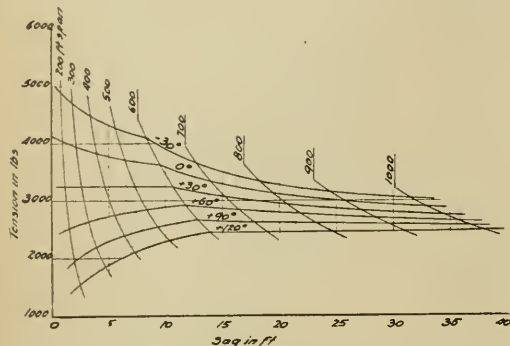


FIG. 7—CHART FOR STRINGING WIRE — 250,000 C.M. Hard-Drawn Copper Wire for Spans 200 to 1000 Ft. Based on Tension of 5,900 Lb. at Zero F., 8-Lb. Wind Pressure and 1/2 In. Ice for Spans 600 to 1000 Ft. Inclusive, and Tension of 3,250 Lb. at + 30 deg. F., with no Wind and no Ice for Spans 200 to 500 Ft. inclusive.

5,900 lb. was specified at 0 deg. F. with ice and wind, the tension for a 200-ft. and 300-ft. span at - 30 deg. F. with no ice and no wind is exceeding this value and the computation for these two spans would have to be altered.

Since unequal spans cannot be avoided in transmission lines, the absolute pull along the line can be lessened materially. This is accomplished by reducing the tension in the shorter spans, i.e., by altering the assumed basis of maximum loading. From the chart of Fig. 6 it will be noticed that for a 600-ft. span at + 30 deg. F. the tension is 3,250 lb. Producing this + 30 deg. F. temperature curve horizontally to the left and rectifying all curves to the left of the 600-ft. span, the stress will be distributed more equally. Accordingly, the new basis to work from for all spans less than 600 ft. is a tension of 3,250 lb. at + 30 deg. F. with no ice and no wind.

The chart of Fig. 7 shows this rectification of spans from 200 ft. to 500 ft. If we attempt to couple a 200-ft. span with a 600-ft. span, we find that at - 30 deg. F. a difference of $4,880 - 4,110 = 770$ lb. in favor of the short span and at + 120 deg. F. a difference of $2,465 - 1,545 = 920$ lb. in favor of the long span, against a former difference of 2,290 lb. The maximum tension for the 200-ft. span computed from the new basis would be 5,520 lb.

In conclusion, it might be said that the chart submitted gives all necessary information to the engineer in the field for stringing wire according to the best engineering practice.

BRITISH TOWN PLANNING CONVENTION

DELEGATES from thirty-six countries attended a Town Planning Convention held in London, England, recently, under the auspices of the International Garden Cities and Town Planning Association. The various Dominions of the British Empire sent delegates, and the Canadian contingent included representatives of Quebec, Ontario, British Columbia, and Nova Scotia. Among the countries directly interested in the conference were Japan, Palestine, China and the new Irish Free State. Belgium, with sixty delegates, had the largest representation outside of Great Britain.

Ebenezer Howard, president of the Association, in welcoming the visitors, made special reference to Belgium, which he complimented on the way in which it had met the replanting and rehousing in the areas devastated by the war. He also referred to France as having done excellent work in its devastated districts. President Howard said that in the Overseas Dominions, the town planning and garden cities movement was growing stronger every day.

MILLION-VOLT SINGLE TRANSFORMER

ENGINEERS of the Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa., announce the construction of the highest-voltage single transformer ever built. With capacity of 1,000 kv-a., it is capable of delivering 1,000,000 volts above ground, and was built for the Westinghouse experimental laboratory at Trafford City, Pa. It is said to be the only single transformer of such high above-ground voltage ever built.

The transformer is built on the principle of distributing electrostatic stress as developed by C. L. Fortescue, of the Westinghouse Co., about eight years ago. The terminal bushing is the largest ever built in the Westinghouse shops, and on this account special machines had to be fitted to turn it. Its length is 19 ft., and it is 41 1/2 in. in diameter and weighs about 9,000 lb. The static shield is 10 ft. in diameter and 20 in. deep.

The construction of this high-voltage testing transformer is the result of research work by Westinghouse engineers. The company states that it has made research a feature of its activities, believing that such work must necessarily precede commercial progress in any line. This has been practically true in the matter of the gradual increase of transmission voltage. Testing facilities capable of producing voltages four or five times as great as the transmission voltages are necessary in connection with development work on insulators and apparatus.

Some testing in the past has been done at voltages approximating 1,000,000 volts, but these tests were accomplished by connecting two transformers in series, grounding the connection between them and using the voltage between line terminals. One million volts was produced first in this way by the Westinghouse Company in 1913. When conducting tests by this method, an artificial ground is used which is one-half of the test voltage below ground. Results obtained by this method, however, are said to be rather questionable, even when conducted with great care. Much more reliable tests, state the Westinghouse engineers, can be made by means of a single transformer capable of delivering the full test value above ground.



Work on the Great Falls hydro-electric plant, 186,000 h.p. capacity, being built by the Fraser-Brace Co. of Montreal, for the Manitoba Power Co., is progressing rapidly. Excavations for the power site are almost completed and by the end of the present month the work of pouring concrete will be started.

SEWAGE DISPOSAL FOR SMALL MUNICIPALITIES

Report of Committee on Sewage and Sanitation Presented at the Convention of American Society for Municipal Improvement, Baltimore.

CHAIRMAN John F. Skinner of the Committee on Sewerage and Sanitation has furnished "The Canadian Engineer" with the following report which is intended to cover villages and small cities.—EDITOR.]

One principle only may be postulated which will apply to all cases, viz.: Each situation is a distinct problem to be studied and solved truthfully, always remembering that the truth upon any subject is obtained by marshalling all the facts in their proper relations. In view of the above it may be helpful to outline the data to be considered, the conclusions therefrom, the resulting type of plant applicable, the elements of disposal plants and certain observations.

Data to be Considered

(1) Physical Conditions

- A. Area of Territory
 - (a) Present
 - (b) Future
- B. Character of Territory
 - (a) Compact or scattered
 - (b) Residential, commercial or industrial
 - (c) Flat or hilly, gentle or steep slopes
 - (d) Low, requiring pumping, or high, allowing gravity outfall
 - (e) Geology, sand, gravel, clay, quicksand, rock
- C. Population, Density and Total Numbers
 - (a) Present
 - (b) Future
 - (c) Resident
 - a. home and business
 - b. home only (commuters)
 - (d) Non-resident (industrial)
 - (e) Seasonal (summer colony)
 - (f) Transient (summer resort)

(2) Sewerage System

- A. Character of Sewer System
 - (a) Separate
 - (b) Combined
- B. Amount of Sewage
 - (a) Dry weather flow
 - (b) Maximum flow (obtained by):
 - a. Amount of water supply and population.
 - b. Sewer gaugings
 - c. Proportion of storm water admitted in case of combined system
 - d. Precipitation, run-off data, per cent impervious, etc.
- C. Character of Sewage
 - (a) Domestic waste
 - (b) Industrial waste
 - a. Solids
 - b. Color
 - c. Odor
 - (c) Ground water
 - (d) Street wash (in case of combined system), quantity of manure, leaves, grit, etc., received through surface sewers
 - (e) Settleable and suspended solids with their settling rates
 - (f) Effect of various precipitants, especially in the case of preponderating trade wastes
 - (g) Oxygen demand, putrescibility

(3) Body of Water Receiving Effluent of Plant

- A. Non-potable, no bathing
- B. Salt water with beaches to protect
- C. Tidal stream, bathing
- D. Fresh water lake
 - (a) Bathing

- (b) Water supply
- E. Fresh Water Stream
 - (a) Large or small
 - (b) Riparian uses
 - (c) Industrial uses
 - (d) Bathing
 - (e) Water supply
- F. State regulations regarding discharge of sewage
- G. Currents — dilution and dispersion
- H. Deep or shallow
- I. Constant or variable level
 - (a) Fluctuation due to tides
 - (b) Fluctuation due to precipitation
 - (c) Fluctuation due to storage
- J. Temperatures — water and sewage
- K. Wind — prevailing direction and intensity
- L. Vegetation
- M. Pollution other than by this effluent
- N. Protection of fish, oysters, etc.
- O. Visual and aerial nuisance
- (4) Funds Available for Sewage Treatment

Conclusion From the Data

(1) Volume of Sewage to be Treated

- A. Dry weather flow — present and future
- B. Maximum flow — present and future
- C. Distribution — through day and week

(2) Character of Sewage

- A. Variation in density
- B. Solids — settleable and suspended
- C. Oxygen Demand — putrescibility
- D. Color, odor, etc.

(3) Character of Treatment Indicated

- A. Discharge into non-potable water
 - (a) Remove floating and coarse suspended objects
 - (b) Remove grit where necessary to prevent deposits in stream, lake or long outlet pipe
- B. Discharge into small non-potable stream
 - In addition to (a) and (b) above treat further sufficiently to prevent nuisance
 - (c) Remove settleable solids and 40 to 90% of suspended solids by tank treatment
 - (d) Oxidize effluent
- C. Discharge into large potable stream or lake where there is ample dilution and oxidation. Treat as in (a) (b) and (c). (c) may be omitted if the effluent does not appreciably affect the receiving body of water
 - (e) Disinfect the effluent when sewage pollution, possible from the effluent, can be detected near bathing beaches or water works intakes
- D. Discharge into small potable stream or lake
 - Treat as indicated in (a) (b) (c) and (e) above.

Type of Plant Applicable

The above operations may be accomplished respectively by means of the following devices:

- (a) Remove floating and coarse suspended objects, by coarse racks, fine racks or mechanical screens
- (b) Remove grit, by detritus chambers
- (c) Remove settleable solids and 40 to 90% of suspended solids, by tank treatment with or without precipitants
- (d) Oxidize effluent, by irrigation, sand filtration, contact beds, trickling filters, or aeration or activation
- (e) Disinfect the effluent, by liquid chlorine or bleach

Elements of Disposal Plants

(1) Removal of Solids

A. Screening devices

- (a) Coarse racks, bars 2 in. to 4 in. apart for large objects in combined sewage
- (b) Fine racks: Bars $\frac{3}{4}$ in. apart for coarse floating and suspended matter in fresh sewage, when followed by tank treatment
- (c) Fine mechanical screens: For coarse floating and suspended matter, particularly in the case of stale

or septic sewage when followed by further treatment. The removal is mainly garbage. Also where no further treatment is required, as above in Section 3-A and C.

B. Detritus chambers: For the removal of grit and heavy (mainly inorganic) solids which will settle from a stream flowing at a mean velocity of one foot per second. This should precede fine racks or screens; more important for combined sewage

C. Tanks: For the removal of settleable solids and 40% to 90% of suspended solids

- (a) Septic tanks, 8 to 12 hours detention
- (b) Biolitic tanks
 - a. Agitation chamber 6 to 8 hours detention
- b. Settling chamber 2 to 3 hours detention
- (c) Imhoff tank
 - a. Flow chamber—3 hours mean detention for best removal
 - b. Digestion chamber—4 to 6 months sludge
- (d) Settling tank—3 hours mean detention with continuous removal of sludge for separate digestion, with or without precipitant

(2) Oxidation of Effluent

- A. Dilution in lake or streams
- B. Broad irrigation: Only applicable under unusual conditions of isolation and cheap land
- C. Sand filters: Only applicable where large areas of natural sand and gravel are available in suitable location
- D. Contact beds: For locations so close to habitations that the spray from sprinklers would cause nuisance.
- E. Trickling filters of broken stone or brush. This is probably the best known method of artificial oxidation of tank effluent. When carefully designed and constructed they have been uniformly successful on well settled sewage which does not contain unusual elements, trade wastes, etc. They are expensive to construct but cheap to operate. They should be followed by settling basins for secondary sludge.
- F. Aeration or activation: The process known as "Activated Sludge" produces a well oxidized effluent by means of agitation and thorough mixing of sewage, air and previously aerated sludge. It is a plant relatively cheap to install but most expensive to operate. It requires less area than any other artificial method of oxidation but it is limited to situations where cheap power is available where fertilizer can be produced as an offset to the expense of operation and upon a large scale. Certain adaptations still in the experimental stages offer promise of success.

(3) Disposition of Solids

- A. Screenings
 - (a) Incineration
 - (b) Composting for fertilizer
 - (c) Treated as garbage
 - a. Buried. b. Burned. c. Reduced.
- B. Grit: Dumped for filling
- C. Sludge
 - (a) With or without digestion
 - a. Dumped in deep water or discharged during flood conditions
 - b. Lagooned or dried in furrows and covered
 - (b) With digestion—drained on drying beds and used
 - a. For fertilizer
 - b. For fertilizer base
 - c. For filling

(4) Disposition of Effluent

- A. Direct into receiving body of water
- B. Through long conduit to avoid local pollution
- C. Chlorination where necessary with
 - a. Liquid chlorine or
 - b. Bleach.
- To Protect
 - (a) Water supply

- (b) Shell fish
- (c) Bathing beaches.

Observations

There are certain details in the construction and operation of disposal plants which are too often overlooked, as they are generally omitted in the literature of the subject.

Provide the plant, where necessary, with:

1. Water under pressure
2. Industrial railway
3. Light
4. Heat in building for cold weather
5. Repair shop with forge, pipe cutter, stock and dies, and bench tools
6. Laboratory apparatus
7. Power for the above and other uses
8. Labor under competent supervision.

The moving of sludge, grit and screenings is often most conveniently accomplished by an industrial railroad preferably operated by storage battery locomotives, as this method obviates the danger of exposed trolley wires.

In fortuitous situations like two of the present and two of the future plants of Rochester, N.Y., power is obtained from the fall of the sewage and fuel is only used for heating, otherwise it must be provided and becomes an important element in the expense of the plant.

A certain amount of labor may be effectively employed in hosing and washing down decks and walls, skimming tanks, agitating scum in gas slots by streams or by the use of tampers to prevent the formation of a continuous crust and afford free vent for the gas.

Labor is also required in operating gates, removing sludge, grit and screenings; raking over the surface of trickling filters when the first "ponding" appears, inspecting and cleaning spray nozzles daily as well as the distributing and collecting pipes. Such operations are most certainly performed when a methodical schedule is maintained and directed by a responsible man on the job.

Flies in large numbers are disgusting around a disposal plant and can be largely avoided by reasonable precautions. As they come to obtain food, they can be discouraged by keeping all surfaces washed clean and by barring floating solids from quiescent water in tanks. In the relatively rapid current of a detritus chamber in advance of screens, it is only necessary to keep the walls washed clean. Grit from a properly operated detritus chamber will not attract flies, neither will well digested Imhoff sludge, whether wet, spadeable or dry.

Fine screens and efficient scum boards, hosing and occasional skimming will minimize the floating solids in a settling tank, or reduce them to such size that they will not support a fly. Screenings attract flies as they are largely composed of garbage. They should be covered with grit, earth or ashes or compacted and sprinkled with borax solution.

Small moth flies which are found in warm weather on and above a trickling filter come from the larvae resident on the stones just below the surface. They do not travel far from the filter and are not objectionable. They may be kept out of other portions of the plant by screening doors, windows and other openings, and by providing curtain walls dipping below the surface of the sewage.

Odors. The best plan is to surround the plant by a large tract of land municipally owned and controlled, but even then certain odors which reach to considerable distances, may produce nuisance unless controlled.

Well digested Imhoff sludge is not objectionable and can be noticed only in the immediate neighborhood. Odor from screenings can be controlled by covering as suggested above. Liquid sewage when undisturbed does not give much offense, but when it is broken up in rapid currents by means of baffles, or tumbled over weirs, it becomes more noticeable.

Odors have been found objectionable at distances of half a mile when sewage is blown into the atmosphere as spray, by air under pressure. This nuisance does not occur

when the wind direction is unfavorable, nor yet when there is perfect quiet. A strong wind or good breeze does not seem to cause trouble to leeward for the water is too attenuated when mingled with a considerable volume of air. Smells seem to be carried further with a scarcely perceptible drift of the air. The remedy for this condition consists in covering so that rising spray or vapor will impinge upon the under-surface of the cover and be condensed.

At the main (Irondequoit) sewage disposal plant of Rochester, N.Y., where the total cost, including the site of 315 acres on the shore of Lake Ontario, was \$975,500, and where 45 feet head is available most of the time, the cost of accessories such as water works, railroad, grading, light and power was \$108,000. In general such accessories, including equipment of shop and laboratory, may amount to 10 or 15% of the cost of the plant.

AMERICAN WATER WORKS ASSOCIATION

ANOTHER successful convention is anticipated when the American Water Works Association meets at Philadelphia on May 15-19, 1922, both dates inclusive. The following tentative program which has been arranged, includes the following papers. Monday, May 15, will be devoted to registration, group and committee meetings, and presidential address.

Tuesday Morning

1. Business Section.
Report of Publication Committee.
Report of Finance Committee.
2. G. W. Fuller—Philadelphia Water Supply, Present and Proposed.
3. F. C. Jordan—Fire Prevention and Fire Protection in Relation to Public Water Supply.

Tuesday Afternoon

1. J. Waldo Smith—Development of the Schoharie Watershed—Catskill Water Supply.
2. M. M. O'Shaughnessy—Hetch Hetchy Water Supply.
3. John H. Gregory—Tentative.
4. Wm. A. McGraw—The Construction of the Loch Raven Dam.
5. G. E. Willcomb—Twenty Years Filtration Practice at Albany.

Tuesday Evening

A.W.W.A. Manufacturers' Program

1. Peter Payne Dean—Short paper on Dean Control Valves, with moving pictures.
2. Thomas F. Wolf—Underground Leakage and its Relation to Mains and Services.
3. John Oliphant—Pneumatic Pumping, Up-to-Date.

Wednesday Morning

1. Report of Committee on Standard Forms of Contract.
2. Report of Council on Standardization.
3. Report of Committee on Industrial Wastes in Relation to Water Supply.
4. Report of Committee on Watershed Protection.
5. George R. Taylor—Problems in the Reforestation of Watersheds.

Wednesday Evening

1. J. W. Ledoux—Some Observations Concerning Wood Pipe.
2. Report of Committee on Standard Specifications for Cast Iron Pipe and Specials.
3. C. E. Inman—Experience with Cast Iron Water Pipe for Pressures Higher than Allowed by Standard Specifications.
4. Peter Gillespie—Centrifugally Cast Iron Pipe (with slides).

Thursday Morning (Superintendents' Day)

1. L. H. Enslow—Water Chlorination Control in Virginia.
2. Report of Committee on Physical Standards for Distribution Systems.
3. M. M. Borden—Air and Relief Valves.
4. Wm. P. Mason—Instances of the Value of a Sanitary Survey.

5. F. A. McInnes—Causes of Failure of Cast Iron Pipe.
6. Topical Discussion, Breaks in Water Mains.

Thursday Afternoon

1. George E. Cripps—Equipment and Shop Facilities for Maintenance of Water Works Systems.
2. Topical Discussion.
3. W. R. Conard—Present Day Tars for Pipe Coating.

Chemical and Bacteriological Section

1. Report of Committee on Standard Methods of Water Analysis.
2. Report of Committee on Colloidal Chemistry in Relation to Water Purification.
3. Report of Committee on Testing Water Works Materials and Supplies, Lime Specifications.

Thursday Evening

1. S. T. Powell—Industrial Water Supplies.
2. David A. Decrow—Reciprocating Pumps.
3. S. P. Felix—Turbo-centrifugal Pumps.

Friday Evening

(Joint Session with Chemical and Bacteriological Section)

1. Frank E. Hale—Plant Control of Chlorination by the Excess Chlorine Method as Employed in New York City's Water Supplies.
2. W. W. Brush—Responsibility of the Water Works Superintendent to Prevent Tastes and Odors due to Microscopic Organisms.
3. W. A. Sperry—Further Notes on Chlorine Control at Grand Rapids.
4. Norman J. Howard—Recent Practice in the Removal of Odors by Aeration, Filtration and other Processes.
5. Wm. J. Orchard—Recent Developments in Chlorination

Friday Afternoon

1. Report of Committee on Meter Schedules.
2. T. A. Leiken—Steel Pipe.
3. G. A. Elliott—Steel Pipe.
4. Wm. A. Megraw—Design, Construction and Operation of a Balancing Reservoir.

Chemical and Bacteriological Section

Symposium on Tastes and Odors

1. From Sewage Pollution.—Leader.
2. H. E. Jordan—The Effect of Wastes from Oil Refineries upon the Operation of the Filter Plant at East Chicago.
3. From Chlorine Treatment.—Leader.
4. F. H. Waring—Tastes and Odors from Decomposition and Putrefaction of Organic Material in the Maumee River Water.
5. George C. Bunker and Henry Schuber—Reactions of Culture Media.
6. Norman J. Howard—Chlorination Prior to Filtration, with Special Reference to Efficiency, Economy and Removal of Excess Chlorine.
7. Edward Bartow and G. C. Baker—Water Softening by Base Exchange.

CALL FOR NOMINATION CARDS

C. D. BROWN, Walkerville, Ont., Secretary of the Canadian Section of the American Water Works Association, is very anxious that the Canadian members should return their nomination cards to him as soon as possible. An effort is being made to send out the program for the forthcoming meeting at Brantford along with the nomination blank in the same envelope. In order to do this the nomination papers will have to be printed by May 1, and for that reason it is most important that the nomination cards be returned to Mr. Brown at the earliest possible date.

DEVELOPMENT IN PAVEMENT CONSTRUCTION*

No Outstanding Changes in Major Methods of Construction — Developments in Details — Curing Concrete Base — Treating Gravel and Sand-Clay Surfaces

By Charles M. Upham
North Carolina State Highway Engineer.

NO GREAT changes have been brought about or new methods introduced in the construction of modern type pavements during the past two years, but rather energy has been expended in the development of many details, which had previously proven to be hindrance in economical road construction. With the present character of road materials, and the mechanical devices now in use, the types of pavements seem to have become established and to have settled within distinctive limits.

For years, roads have consisted of the grading, the construction of the drainage structures, and the surfacing. There have been no great changes in grading other than the more careful selection of materials, and the few mechanical improvements for handling rock and earth. Drainage structures have for a long period been built of wood, steel, rubble or concrete masonry. Road surfaces have consisted of soil, selected soil, or metal composed of artificial aggregates held together with some kind of binding material.

The only recent changes have been in the discovery and development of details, and the methods of handling aggregates. The building of macadam roads marked a great change in highway construction, and for a long time macadam was universally adopted as the standard road surface, since it satisfactorily met the needs of traffic at the time. A few inventions such as the steam roller and the stone crusher assisted the development of road construction at the early part of this period. With the change of traffic demands it was found that this type of macadam, as then built, was inadequate in many instances, and consequently road builders began to devise new surfaces to withstand the new classes of traffic. The result has been that present-day standard pavements are still undergoing changes and developments and, while recent years have seen very few radical changes in the principal characteristics of road surfaces, developments in the details of construction have been numerous, and it is impossible to mention more than a few of the most important ones.

Developments in Construction Details

The construction of half-width roads can hardly be called recent, although they have given satisfactory results. This method of road construction releases traffic from the long rough detours and renders the road available for traffic during construction. The method has been utilized satisfactorily in the construction of bituminous pavements, and, in a few instances, in the construction of water-bound macadam, but it is generally used in concrete road construction. Where this type of road is constructed for heavy duty it is often heavily reinforced, each half of the road being kept separate from the other half, so that the complete pavement really consists of two strips, laid side by side. In this method of construction the heavy reinforcement is longitudinal, on account of the center line joint taking up the vertical movement of the pavement, thus eliminating longitudinal cracking, and the transverse cracking is decreased to a minimum, even in those sections of the country subjected to low temperature.

In other instances "tie roads" have been used to join the two strips of pavement together. This method, however, introduces difficult details in construction, and up to the present time has shown no particular advantage over the other. The practical advantage of the longitudinal joint lies in the fact that the construction joint is easily maintained, and is not objectionable in appearance, while

a jagged, irregular longitudinal crack is difficult to repair and is also unsightly. In some states this longitudinal or center line construction joint is provided, even though the pavement is constructed in one operation, the advantage being the same as when the pavement is constructed in two sections.

Another recent development in road surface is the widening out and the reclaiming of old macadam roads by building a strip of hard surface pavement on each side of the macadam. On either side of the old macadam road varying from 5 to 10 ft. in width, a strip of concrete is placed from 9 to 10 ft. wide; these strips being sometimes reinforced. This method gives a comparatively wide pavement, and makes a road useful which would otherwise be too narrow to be of any service to traffic.

Another development in road surfacing has been the general tendency to increase the amount of reinforcement in concrete roads.

In recent years many engineers were reinforcing their roads with metal wiring, approximately 25 to 27 pounds to 100 sq. ft. Now it is a common practice to use approximately three times this amount, with the tendency to still further increase the weight of material. Specifications of North Carolina for 1921 will undoubtedly call for metal amounting to nearly 100 pounds for each 100 sq. ft. The use of heavier metal has effected a large saving in the cost of roads. The present price of steel has made possible considerable saving in cost by the construction of thinner concrete pavements. Where reinforcement has been used in most cases the road has been constructed of a universal thickness, resulting in a considerable saving of concrete.

Batch Transfer Method

Much progress has been made in the methods of laying concrete pavements, the tendency being not to allow concrete materials to be placed on the subgrade. The batch transfer method which is now becoming a standard form of construction, has proven economical, in most instances, and capable of large yardage. There have been many combinations of this method, such as hauling by industrial railway with the batch boxes carried upon the railway trucks, truck hauling with the batch boxes loaded on the trucks, and trucks provided with batch compartments. In some instances the batches have been hauled a portion of the distance by trucks and transferred to an industrial railway. This has proven a very economical combination in many cases.

The central mixing plant for concrete pavements is now being used on many projects. In most cases the ready mixed concrete is hauled to the job by means of trucks. The only detail in this method which can be considered questionable, is the transferring of the concrete from the trucks, owing to the possibility of the aggregates becoming segregated. This trouble will, no doubt, be overcome, when this method of construction will gain in popularity.

Curing Concrete Base

In a few instances engineers are calling for a piece of bituminous surface road to be constructed of 1-2-4 concrete and requiring that the concrete base be properly cured for a period of at least two weeks. For a long time the curing of concrete pavements has been neglected, and it is only recently that this detail of construction has been given proper attention. One of the most important developments which has been brought about recently is the use of the burlap covering in the early curing of concrete surface. The finished pavement is covered with strips of burlap, approximately 4 ft. wide and extending the entire width of the pavement. This burlap is kept wet and then placed on the finished concrete surface from about 10 to 20 ft. back of the finishing operation; the slight marking of the surface from the burlap being negligible. The burlap should never be allowed to dry out, and thus the concrete does not lack the necessary water for hydration in the early periods, a condition which has often existed in the other methods of curing concrete roads. The writer considers that this is one

*Paper read before the American Association of State Highway Officials.

of the greatest developments, and one which has actually improved the lasting quality of concrete. As soon as the road surface becomes hardened the burlap is rolled up and ready for the next day's work, while the concrete road surface is covered with earth, sprinkled and wet in the usual manner.

Many specifications are now including regulations as to the riding qualities and evenness of the concrete road surface. Ordinarily this cannot be tested until the following day when the concrete has hardened sufficiently to bear one's weight. An appliance was invented recently which consists of an extremely light straight edge, which may be fastened to the end of two handles and extended over the road to test the surface before it has become hardened.

Many other experiments have been carried out for curing concrete pavements, but no definite results have been obtained. One state has used calcium chloride in solution applied on approximately one inch of earth covering. Another method tried has been the covering of the concrete surface with a heavy asphaltic oil. The oil was applied to the road in the proportion of about 6/10 gallon per sq. yd., and after the curing period of two weeks the asphalt was peeled off and again used.

Another extraordinary experiment has consisted of the oiling of the subgrade preparatory to laying the concrete, the object being to prevent mud forming during the light showers. It has been found that when the light truck is used, this oiling proves to be a considerable advantage; no doubt the oil offers some assistance to the stabilization of the subgrade.

New Construction Methods

While for a long time it has been customary to use wire fabric in the reinforcement of concrete highways, steel bars are occasionally used, and while there has been no development in regard to the use of this fabric reinforcement, there is, however, a change in the method of using steel bars. This new method consists of making a mat consisting approximately of 10 to 14 bars laid transversely, and about 5 bars longitudinally. The mat is then wired together and handled as sheet reinforcement.

The use of dowels at the transverse construction joint can hardly be considered new, because this method has been used for several years, and found to be very satisfactory in overcoming the tendency of one slab to rise above the other.

Another construction method is the installation of fibre conduits placed transversely across the road at various intervals, especially in small towns and villages. It is the function of these conduits to provide a means of laying gas, water and electric wiring across the road without breaking up the pavement.

In the construction of sheet asphalt surfaces there is a tendency to be more liberal in the grading of sand aggregates, and the use of a lower penetration asphalt. There is also a tendency to use a 3-wheel roller in compacting the sheet asphalt surface. While this is not absolutely new, its use has never been universal.

Another new development is a combination of a binder course and sheet asphalt surface in the one course, which virtually consists of a stone-filled sheet asphalt; the stone comprising from 25% to 60% of the entire surface. When this surface is used no binder course is laid, and the surface is compacted as an ordinary asphaltic concrete.

Recent developments in brick pavements have shown that the vertical fibre brick laid on a concrete base and sand cushion, grouted with a bituminous material is capable of withstanding the heavy traffic.

Progressive Type Road

The findings of the Subgrade Committee have shown that the traffic bearing properties of a pavement depend greatly upon the stability of the subgrade, and that the subgrade can be greatly stabilized by being mixed or covered with a non-capillary material, such as sand, gravel or top

soil. This has led to the development of what, in North Carolina, has been termed the "Progressive Type" road, which consists, first, of grading the road and building the drainage structures, and then surfacing with gravel, sand clay or top soil, which in effect, is nothing more than the construction of a subgrade for a hard surface pavement which can be constructed in the future. This can be maintained as a subgrade highway for medium traffic at a reasonable cost, and, when occasion demands, it can serve as a subgrade with high bearing value, for any type of surface desired.

Many states are situated similarly to North Carolina to the extent of having a large mileage of sand clay, top soil, or gravel surfaces. There has been much experimenting in the attempt to secure a bituminous material which would satisfactorily preserve this type of road surface. It has been generally found that a bituminous material sufficiently light to penetrate this surface would have practically no binding qualities, and that a bituminous material sufficiently heavy to have binding qualities would form a mat on the top of the road surface, and soon peel off, due to the dusting of the road surface directly underneath the bituminous covering. The weak point in this treatment was not in the bituminous blanket, but in the contact of the bituminous blanket with the road surface.

Treating Gravel Surfaces

North Carolina is attempting to develop a method which will correct this weakness, and provide a contact between the bituminous covering and the road surface. The method consists of softening the road surface by means of sprinkling and then rolling into this surface broken stone or gravel of approximately 1½ in. in size. After this has become thoroughly imbedded in the top soil or sand clay it is allowed to dry out, and subjected to traffic for a short period, after which it is swept clean by brooming. The road surface now consists of a single layer of crushed stone imbedded in the strong and rigid sand clay or top soil surface, and forms a satisfactory bond of contact for the bituminous material. Thus a sufficiently heavy material to have binding qualities can be applied to this sand clay road, and the layer of broken stone will prevent the dusting up of the road surface directly underneath the bituminous mat. By waterproofing the top soil or sand clay in this manner, a strong pavement is preserved and after the first application of the bituminous material a mat can be built by using various types of pavement. While this method has not been in practice long enough to prove its complete success, the developments show that for a slight expenditure, a sand clay or top soil road can be materially improved.

BRITISH RESEARCH IS AMBITIOUS

WHILE an increasing amount of electrical research work continues to be done by individual electrical engineering firms in Great Britain, co-operative research is being developed on an ambitious scale. The Research Association, formed by the British Electrical and Allied Manufacturers, is expending about \$40,000 a year for 5 years on this type of research, which is aimed at the benefit of all concerned in the electrical industry.

Practically every leading section of industry in Great Britain has its organized co-operative research association. In the case of brass, copper and other metals not containing iron, a great deal of very interesting research is now being carried on. The casting of brass, the influence of impurities on the working of copper, the electric melting of non-ferrous metals, and the grinding, jointing and polishing of such metals are being closely studied.

Perhaps the most important part of this research lies in the investigation of corrosion. The production of rustless iron and steel has stimulated the brass and other industries to give attention to the causes of corrosion. It is stated that the examination of tarnishing which is the first stage towards corrosion, has already yielded very interesting results.

PLAN TO BUILD NATIONAL RESEARCH INSTITUTE

Research and the Problems of Unemployment, Business Depression and National Finance in Canada
National Research Institute Proposed

ONE of the serious drains on the strength of the Dominion of Canada is the annual loss of engineers, chemists, scientific farmers, and technical experts, whose training paid for by Canadians in Canadian schools and universities supported by Canadian public money, thus goes out to make foreign countries rich and place Canada further in their debt for foreign goods and services.

Monopolies of Knowledge

Monopolies of knowledge, that is, monopolies of special branches of technical knowledge, constitute one of the most powerful weapons of trade to-day.

Secret agreements, combines, trusts, and the ordinary method of "conspiracies in the restraint of trade," become very mild and impotent weapons when compared to such formidable instruments as, for example, a secret chemical formula that might be scribbled on the back of a calling card.

In the bloodless wars for international trade it is the armies of chemists and engineers that must be mobilized, drilled, and directed against the parapets of unknown scientific facts. Export duties, credit leagues, intelligence departments, persuasive salesmanship, and even the magic of a great flag, cannot win or cannot hold, for long, trade for a country whose producers are not armed with scientific knowledge of their work.

A great camera manufacturing concern in the United States is able to dominate its field in at least half the world because it knows more scientific secrets of that trade than anyone else.

Because, if a new concern started in opposition, it need only reach into its pigeon holes for some new formula, not otherwise convenient to exploit at present, by which to raise its product one step beyond the competition of the would-be rival.

So in steel-making!

So in the manufacture of electrical apparatus!

So in textiles!

So in chemistry!

So in agriculture!

So in every important branch of human industry!

So in Canada, as compared to other Nations, everyone of our industries is threatened and must ultimately fall under the thrall of foreign domination unless it keeps pace with the advances in technical knowledge.

So, unless we master all that is to be known regarding the nature and possibilities of our vast supplies of varied raw materials, Canadians must ultimately find themselves at the mercy of foreigners who know how to prepare our riches for purposes of commerce.

What Other Nations Do!

Fifty concerns in the United States retain research departments at costs ranging from twenty-five thousand dollars to two million dollars a year.

In England, France and Germany, the race for technical knowledge for purposes of trade gathers speed.

The mere digger-out of raw material gets the pay of a laborer.

The nation that can finish its raw materials trebles and quadruples its rewards.

The question is, shall Canada keep reasonably in pace with the modern movement? Shall Canada add to her natural possessions a superior knowledge of how to use them?

Can the needed variety of occupations for ambitious Canadian sons and daughters be maintained unless she does make place for such knowledge and encourages those who extend it?

Can the burdens of Canadian taxation and the evils of unemployment be off-set if Canada, in her struggle for

markets and for good returns on her wares, does not possess herself of the instrument of technical knowledge?

The Government Task

No Government should be expected to bear all the cost of discovering new scientific truths; that of course is paternalism. Most of the cost of this work must be left to private enterprise since it is by private enterprise that the new knowledge will be exploited, properties laid out, employees set to work, and production carried on.

But if every branch of Canadian enterprise starts independently in the pursuit of new scientific information, there is bound to be tremendous waste. Many duplicate laboratories would be required. Much over-lapping of effort would go on. In one laboratory time would be lost in proving or disproving what had already been learned in a laboratory somewhere else, and perfectly willing to share the knowledge.

A vast amount of energy and money would be wasted on ground work, instead of having the ground work done as far as possible in common and the money available for research concentrated on the really new effort. To discover a quite simple formula might cost so much for laboratory and men as to discourage the enterprise. A lack of organization would be, therefore, a drag on the wheel.

What Has Been Suggested

It has been suggested in such circumstances, that the universities should be mobilized. But this view has had to be abandoned, not merely because universities are scattered, a difficulty which might be overcome to some extent by subdivision of subjects, but because university routine cannot meet the requirements of the kind of research the business world needs, without damaging the usefulness of the university to its students.

It has been suggested that the scientific staffs attached to certain government departments, as for example the wonderfully efficient Department of Mines at Ottawa, or the food and drugs laboratory of the Department of Health, could satisfy this need. But the work, which is needed, cannot be done entirely by the Dominion Government. In many cases investigation can be carried out to the best advantage under one or more of the Provincial Governments, or under federal and provincial authorities in co-operation. Moreover it will often happen that the work cannot be completed as a practical and commercial success without calling on the financial and other help of the industries which are concerned. In all such cases the work lies outside the duties of any government department and should be directed by a body with greater independence and freedom from administrative duties.

Thus in England, in the United States, in Germany, and in Japan, the need for some central bureau of research to synthesize the efforts of its individuals has resulted in the establishment of state institutions equipped and endowed by public funds, controlled by Parliament only in regard to the amount of funds made available for its yearly work.

The Present Proposal

It is proposed that the Government of Canada should set aside \$500,000 to erect and equip a building at Ottawa to be known as "The National Research Institute," and that it should make an annual grant for the carrying on of research in the public interest.

In addition to this kind of work special confidential studies of commercial problems would be carried out for persons or corporations or trade guilds willing to pay the cost of such studies.

This organization would provide a Bureau of Standards, that is, a bureau for the making of delicate tests, measurements or analyses of standard articles of Canadian trade, a work for which Canada has now to depend largely on the services of foreigners.

In other words, instead of having to rely on the scattered and unorganized efforts of gallant and public-spirited investigators; instead of having her manufacturers send their money, as happened in at least one case, to a foreign

state institute to buy research, Canada would have her own central Bureau of Standards for Research.

Here, laboratories and a library would be maintained for public use and a continuous study of Canadian materials would be carried on. Here the results of ground work could be pooled and made available to anyone. Here the engineer or chemist might find the last word in common knowledge of a subject and so have a much better taking-off place for his own research.

Here would be men who might be employed, at cost, to make experiments for this concern or that, their finding in such cases becoming the property of the man or the firm or group of firms who paid the cost. Here the finest instruments and apparatus would be available for those who desired to send their experts to explore some branch of knowledge.

Here, in other words, the state would provide at cost, a common working place and a common repository of such new scientific knowledge as had been acquired at public expense. At the same time, secret discoveries made at the expense of private enterprise, would remain the property of their discoverers, so long as used in the public interest, the public at large benefiting by the stimulus to industry and employment which, in theory at least, follows the application of such private knowledge.

This is what has been done in foreign countries. This is what the Council of Scientific and Industrial Research believes should be done in Canada.

Questions to be Answered

Who knows the secret of exterminating wheat rust? No one. Yet by organized and perhaps long sustained research it can be discovered and meantime lack of this knowledge costs Canada and her farmers millions of dollars per year. Valuable work has been done on this subject under the Department of Agriculture and the Advisory Research Council, but much still remains to be done.

What should a black fox eat? How can this precious little fur-bearer be protected from the ravages of worms? — In the answer lies millions of dollars for Canada, and important steps towards the solution of the question have already been taken.

What use can we make of our tremendous supply of Helium? It was greatly needed during the war as a gas for filling balloons. It will not burn, and at war-time prices Canada is wasting \$50,000,000 worth every day of the week.

It is contained in our natural gas and escapes unused into the air. Can we find another use for Helium besides the filling of balloons? Here is enough money to wipe off our railway deficit. The Research Council has promoted the study of this question; the material is available; it is now a matter of finding uses, in times of peace, for this gas of which Canada can become one of the largest producers.

How can Canada be put into a position to meet its own heavy and increasing demands for fuel? How can the great supplies of lignite in the West and peat all over Canada be utilized for this purpose?

The study of these questions, begun by the Department of Mines at Ottawa and pushed on by the Advisory Research Council, has reached a point where success is in sight.

What practical way can be found of developing and using the enormous quantities of low grade iron ore that exists in Canada?

This, too, has received attention. Much has been done, though much remains to be done and the answer cannot fail to be of immense importance to this country.

What can be done with our straw?

What can be done with our sawmill waste?

What should be done with our liquor from sulphite mills?

What about making artificial fertilizers by the use of our waterpowers?

These are some of the problems awaiting Canada's Bureau of Standards and Research; problems which have en-

gaged the attention of the Advisory Research Council, with promising and even valuable results.

Who Is to Do This Work?

The Honorary Advisory Council for Scientific and Industrial Research consists of eleven of the leading scientists and experts of the Dominion. Not one of them is paid, but, at the invitation of the government, gives his scientific services to the public.

The Council has been in existence about four years, has developed its organization and has studied the whole field of Canadian resources and industries. It has found certain problems facing the Dominion which must be solved if the country's industrial development is to be furthered or even maintained. When it was convinced that a problem was one which might be solved, it selected a group of experts, or sometimes a single individual, and appointed them to carry out the work, arranging at the same time for the provision of the funds necessary for this purpose. In this way the various investigations were carried out by the men most competent to undertake them and under conditions most favorable for success.

It is this body of detached and disinterested men that sponsors the idea and requests the support of the Canadian public for a Bureau of Standards and Research at Ottawa.

From Bulletin issued by Honorary Advisory Council for Scientific and Industrial Research.

CANADIAN SECTION A.W.W.A. MEETING

WHAT WILL undoubtedly prove to be the most successful meeting of the Canadian section of the American Water Works Association is scheduled to take place at Brantford, Ont., on May 12 and 13. This is the third annual meeting of the Canadian section, the last convention having been held at Niagara Falls, Ont., last summer.

A new feature this year will be an exhibit of manufacturers' supplies and it is hoped that as many firms as possible will take space in the Chamber of Commerce rooms at the Kirby House, Brantford, where the exhibition will be held. A cordial invitation is also extended to all municipal officials, commissioners and councillors, etc., whether they are or are not members of the American Water Works Association. Norman D. Wilson, engineer for the Water Works Commission, Brantford, Ont., is looking after the exhibit of supplies, while C. D. Brown, of the Walkerville Water Works, Walkerville, Ont., and secretary-treasurer of the Canadian section, American Water Works Association, is arranging an interesting program of papers on technical topics.

One of the papers on the program is the "Control of Sewage by our Governments," by F. A. Dallyn, engineer for the Ontario Provincial Board of Health, while a paper on the "Treatment of Hard Water" will be presented by Wm. Gore, of Gore, Nasmith & Storrie, Toronto. The manufacture of de Lavaud cast iron pipe will be described by a representative of the National Iron Works Corporation Toronto, with lantern slides. A paper on "Filter Plant Construction" will be read by R. L. Dobbin, superintendent of Waterworks, Peterborough, Ont. This paper will be illustrated with lantern slides. A paper on the "Standardization of Hydrant Threads" will be presented by Norman D. Wilson, engineer for the Water Works Commission Brantford. The Austin Machinery Co. will give a moving picture exhibition of their excavators and backfillers in operation while another interesting exhibit will be that of the Thomson Meter Co., who will give an actual demonstration of freezing one of their new frost-proof, fool-proof meters.

In April 11 issue of the "Canadian Engineer," an error was made in the title of the author of the article on "Smoky Falls Development on the Sturgeon River." C. C. Irvine is assistant to the president and not president of the Spanish River Pulp & Paper Mills, Ltd., as stated.

NEW CEMENT SPECIFICATION, CANADIAN ENGINEERING STANDARDS ASSOCIATION

VALUABLE service to the construction industry has been performed by the Canadian Engineering Standards Association, in the preparation and issuing of a new standard specification for Portland cement. The first Canadian specification for this material was prepared by a committee of the Canadian Society of Civil Engineers and approved by that body in 1916. On the reorganization of the C.S.C.E. as the Engineering Institute of Canada, the Canadian Engineering Standards Association was in 1920 requested to take over and revise the E.I.C. Portland cement specification, together with that on concrete and reinforced concrete. A sub-committee on cement was accordingly organized in January, 1921, including representatives of the Canadian manufacturers as well as of large users of cement. The specification now issued is based not only on that of the E.I.C. but also on that of the American Society for Testing Materials and on the British Standard specification for Portland cement. Consequently, the new document may be regarded as taking into account the most modern developments of cement manufacture, testing and use, both on this continent and in Europe.

The new specification is brief so far as the body is concerned, containing only 23 clauses. These outline the chemical properties, physical properties, packing and marking, inspection and rejection. Following this, there are three appendices. Appendix I dealing with standard methods and apparatus for testing cement; Appendix II with recommended methods for sampling cement; and Appendix III with standard methods for the complete chemical analysis of cement. The more notable points of difference between former specifications and the present one are noted below.

Chemical Properties

According to the new specification, the insoluble residue shall not exceed 0.75% as compared with the 0.85% of the A.S.T.M. specification. Sulphuric anhydride is fixed at an upper limit of 2% as compared with 1.75% under the old E.I.C. specification and the present A.S.T.M. specification. The upper limit of magnesia is set at 4%, instead of 5% as under the A.S.T.M. requirements.

Physical Properties

Fineness is fixed by the requirements that the residue on a standard No. 200 sieve shall not exceed 22%. The E.I.C. specification prescribed that there should not be a residue of more than 8% by weight on a No. 100 sieve, or more than 25% by weight on a No. 200 sieve.

It is now provided that the initial set shall not be less than 30 minutes and that final set shall develop within ten hours. This is similar to the E.I.C. requirement, except that the stipulation that final set shall not occur in less than one hour is deleted. No distinction is made with respect to the apparatus employed for determination of set, as is done under the A.S.T.M. specifications where initial set shall not be in less than 45 minutes as determined by the Vicat apparatus, nor in less than 60 minutes as determined by the Gillmore apparatus.

While the E.I.C. specification provided for a tensile test of neat cement briquettes, the new specification is in agreement with the A.S.T.M. requirements in abolishing the neat cement test. The tensile strength requirements are the same as those of the A.S.T.M., but the strength of 1:3 mortar briquettes at 28 days is set at 300 lb. per sq. in., as compared with 275 lb. per sq. in. under the E.I.C. specification.

It is of interest to note that the specific gravity test is not mentioned. In this matter the specification differs from that of the A.S.T.M. which prescribes the method of making the specific gravity test, although it contains the provision that this test will not be made unless specifically ordered.

Packing

The weight of cement per bag is fixed under the new specification at 94 lb. although heretofore the Canadian

bag has contained but 87½ lb. It is of interest to note that the E.I.C. specification also fixed the weight per bag at 94 lb., but the cement companies continued to provide the 87½-lb. bag. It is now understood that the larger content will be provided.

Standard Testing Methods

Standard methods and apparatus for testing cement are very carefully outlined in the new specification. These are similar to the methods prescribed in the A.S.T.M. specification although a number of important departures and improvements are made.

Accuracy in determination of fineness is facilitated by arrangements with the Surveys Laboratory of the Department of the Interior and the Laboratory of the Department of Public Works, (Ottawa). For example, it is provided that standard No. 200 sieves shall be certified by the former laboratory as free from major defects. For the purpose of enabling users themselves to judge from time to time as to the condition of standard sieves in their possession, the Department of Public Works will furnish on payment a standardized sample of cement or other similarly graded material which gives a residue of 20 to 25% on a standard No. 200 sieve.

Mixing

New methods of mixing based on successful laboratory experience in Canada have been prescribed. The following paragraph dealing with this matter is of interest.

"The dry materials shall be weighed out, placed in a suitable metal mixer bowl (preferably enamelled) and intimately mixed dry with a steel spatula to a uniform color. The bowl and spatula shall be similar in form to those shown in Fig. 1, (not reproduced here—Ed.) the edges of the bent spatula blade being formed to fit the curved side of the bowl. The proper percentage of clean water of the specified temperature shall then be added. After an interval of one-half minute for the absorption of the water, the process shall be completed by vigorous stirring with the spatula, working the material back from time to time in the reverse direction by pressure between the back of the spatula and the side of the bowl. During these operations the bowl can with advantage be revolved if tilted slightly and held in the left hand. The mixing processes shall be continued for at least one and one-half minutes.

The temperature of the room shall be maintained above a minimum of 18 deg. C., and that of the mixing water shall be between 20 deg. C., and 22 deg. C."

In place of the standard spatula prescribed by the specification, it has been found in the laboratories of the University of Toronto that large spoons work very satisfactorily when the mixing is done in a metal bowl of a size such as that suggested in the specification.

Soundness

A new steam testing apparatus constituting an improvement over that provided in the specification of the A.S.T.M. has been recommended. Detail sketches of this equipment are included in the specification, so that anyone wishing to adopt it may have the apparatus made up without difficulty.

New photographs of parts of cement which for various reasons have failed under the soundness test are included in the specification.

Sampling Methods

Great care was exercised by the committee in devising satisfactory methods of sampling. The resulting regulations are entirely new and constitute a distinct improvement on anything heretofore published. It is provided that each test sample which shall contain not less than 8 lb. of cement and shall be made up of at least 16 individual samples, which must be taken from separate bags or packages. It is recommended that one individual sample shall be taken from every fiftieth bag, preferably at the point of loading and after loading has been completed. Individual samples are to be taken from the surface of the cement to the centre of the bag by means of a sampling tube 1 ft. 6 in. long, ¾-in. diameter at the small end and 1¼-in. diameter at the large

end. Methods of sampling are also outlined for cement in bulk or on conveyors.

Complete Chemical Analysis

A departure is made in this specification by including as Appendix III detailed outline of the recommended method for the complete chemical analysis of cement. This provides for the determination of all constituents instead of merely the four chemical characteristics covered by Appendix I, that is loss on ignition, insoluble residue, sulphuric anhydride and magnesia.

Personnel of Committee

The work of framing the specification was carried out by a Sub-Committee on Cement of the Sectional Committee on Cement and Concrete, of the C.E.S.A. The personnel of the Sub-Committee was as follows: Professor Peter Gillespie, (Chairman), University of Toronto; Professor J. Watson Bain, University of Toronto; Professor E. Brown, McGill University; E. Brydone-Jack, Department of Public Works (Canada) Victoria, B.C.; A. G. Fleming, Canada Cement Co., Montreal; W. J. Francis, Consulting Engineer, Montreal; J. A. Jamieson, Consulting Engineer, Montreal; A. G. Larsson, St. Mary's Portland Cement Co., St. Mary's, Ont.; P. B. Motley, Canadian Pacific Railway, Montreal; A. D. Swan, Consulting Engineer, Montreal; A. C. Tagge, Canada Cement Co., Montreal; E. Viens, Department of Public Works, Ottawa; R. B. Young, Hydro-Electric Power Commission of Ontario, Toronto.

R. J. Dnrley, as Secretary of the Canadian Engineering Standards Association, was actively in touch with the work of the Sub-Committee throughout and greatly facilitated the preparation and early issue of the specification.

ACCIDENT AT HYDRO POWER PLANT

Two Units of Ontario Power Co. Plant, Operated by Ontario Hydro-Electric Commission, Destroyed Last Week, Wrecking War-Time Extension to Power-House

UNITS 15 and 16 in the Ontario Power Co.'s plant at Niagara Falls, Ont., were destroyed last week, and Units 11, 12, 13 and 14 were flooded when the generator of Unit 15 burst and smashed the roof trusses, bringing down a large section of roof, which broke the turbine casing of Unit 16. The Johnson valve controlling these two units closed in time to prevent flooding of the whole power house, and the four flooded units are now being run to dry and will soon again be under load.

The Ontario Power Co. is owned and operated by the Hydro-Electric Power Commission of Ontario. Units 15 and 16 were added to the plant during the war under the direction of the engineering staff of the Commission. These units were not specially designed for the service in which they were placed but were purchased at second-hand from a power company in Tennessee. The units were originally designed for approximately 14,000 h.p., but have been delivering about 20,000 h.p. under the head at the Ontario Power Co. plant. This 40,000 h.p. extension to the Ontario Power Co. was undertaken by the Commission as a war measure to relieve the power shortage. The design and construction of this extension was described in "The Canadian Engineer," issue of January 16, 1919, by Thomas H. Hogg, assistant hydraulic engineer of the commission.

The turbines were of the double-runner, central discharge type, with spiral casings, and operated at 187½ r.p.m., under 180-ft. head. The extension of the power house was of concrete and structural steel construction, the roof trusses, crane girders and columns being of structural steel. The structural steel portion of the building was self-contained and independent of the concrete walls for stability. In connection with this extension, 1.3 miles of 13.5-diameter wood-stave pipe were built, and also one of the largest differential surge tanks ever constructed.

It is highly probable that Units 15 and 16 will not be

replaced, as the water required for their operation can be used under greater head—producing much more power—at Queenston; so it is likely that the extension to the Ontario Power Co.'s plant will be scrapped and removed in view of this accident, and work on the third unit at Queenston is being pushed in order to relieve the shortage of power caused by the accident.

Investigation into the cause of the accident is being conducted by the engineers of the commission's staff, but due to the very complete wreck of the unit that caused the trouble, it will probably be difficult to determine whether the accident was due to some defect in the generator or shaft, or to faulty operation.

INTERESTING DISPLAY OF WATERWORKS EQUIPMENT

AS WAS intimated in "The Canadian Engineer" for April 11, it is the intention of the committee in charge of the meeting of the Canadian section of the American Waterworks Association to be held in Brantford, Ont., May 12-13 to invite firms in Canada who are manufacturers of waterworks equipment to exhibit their machinery on that occasion. Arrangements have been completed whereby space for this purpose will be provided free of charge in a room convenient to the hall where the regular sessions of the convention are to be held. Not the least interesting feature of the convention of the American Water Works Association is the exhibition of waterworks equipment and supplies. Anyone who has attended these conventions cannot have failed to be impressed with the real interest which the delegates take in the exhibition of machinery and supplies that are always held in connection therewith. While there are not a great many manufacturers of waterworks equipment in Canada there are nevertheless sufficient to form the nucleus for the building up of a very fine exhibit as a regular feature of the annual meeting and it is to be hoped that those manufacturers who have been invited to exhibit on this coming occasion will do so. It will provide an excellent opportunity for placing before the men in Canada concerned with the design, construction and operation of waterworks plants, specimens of their products.

Already a number of manufacturers have signified their intention to exhibit, and those who have not yet sent in their requisition for space should do so as soon as possible so that the necessary provision may be made. There will be no charge for the space. Messrs. Norman D. Wilson, Chief engineer, Waterworks Commission, Brantford, Ont., and Mr. Jordan of the Dominion Steel Products, Brantford, are the gentlemen who have been appointed to look after this phase of the Convention. Consignments of materials for exhibition purposes should be addressed to the exhibitor, care of the Canadian section of the American Water Works Association, Chamber of Commerce, Kirby House, Brantford, Ont.. A most cordial invitation is extended to all Canadian manufacturers of waterworks equipment whether members of the Association or not to get in touch early with Messrs. Wilson or Jordan regarding the matter as those responsible for the meeting are exceedingly anxious that the exhibition should be really representative as far as the Canadian manufacturers are concerned. The present indications are that quite a number of responsible waterworks men of Canada will be present and machinery manufacturers and supply men should not miss this opportunity of getting into intimate touch with them.

The secretary of the Canadian section of the American Water Works Association is C. D. Brown, Walkerville Water Co., Walkerville, Ont., from whom further information can be secured.

Mechanical Working of Iron and Steel, was the title of a paper read by R. E. Buckley, assistant-superintendent of mills at the Dominion Iron & Steel Co., at a meeting of the Sydney, N.S., branch of the Engineering Institute of Canada

MURRAY REPORT ON HYDRO POWER

New York Consulting Engineer Presents Voluminous Document to National Electric Light Association, Comparing Ontario Hydro with Privately Owned Companies

WILLIAM S. MURRAY, consulting engineer, New York City, who conducted the super-power survey for the United States Government, and who was one of the experts who testified for the Hydro-Electric Power Commission in the hydro-radial inquiry, has presented a voluminous report to the National Electric Light Association of the United States, in which he compares the operations of the Ontario Hydro-Electric Power Commission and those of privately owned and regulated electric utilities in the United States and Canada.

Mr. Murray's report consists of 227 printed pages and cover, 8 by 11 in., the principal sections being: (1) Summary of Conclusions, 2 pp; Part One, 19 pp.; Part Two, 202 pp.; Index, 4 pp. Part One constitutes the report proper, while Part Two gives correspondence and facts ascertained in detail, to support the conclusions reached in Part One. In Part Two there are 5 plates, 36 figures and 24 tables, many of the plates and figures being printed in three or four colors.

The following introductory remarks by the National Electric Light Association appear on the cover:

"Widespread interest in the Hydro-Electric Power Commission of Ontario and a desire for authentic and reliable information regarding its working and accomplishments led the National Electric Light Association to have a report made thereon based on impartial and exhaustive study.

"Accordingly the Association enlisted the services of W. S. Murray, who conducted the Super Power Survey for the United States Government on the Atlantic seaboard between Boston and Washington, and who in addition is conversant with Canadian conditions, having acted for municipal and provincial bodies in a consulting capacity. In this work Mr. Murray was assisted by his partner, Henry Flood, Jr., formerly Secretary-Engineer of the United States Government's Super Power Survey organization.

"The report herewith made public by the National Electric Light Association covers the investigations made by Messrs. Murray and Flood from August 22, 1921, to February 10, 1922, and presents in a comprehensive and comparable way the advantages of electric service rendered by privately owned and publicly regulated utilities in the United States and Canada contrasted with that supplied by the most notable government-owned utility in the Western Hemisphere, i.e., the Hydro-Electric Power Commission of Ontario."

Mr. Murray's "Summary of Conclusions" follows.

"After a careful analysis of the governmentally-owned controlled and operated electric utility structure as represented in the Hydro-Electric Power Commission of Ontario, I am of the opinion, firstly, that the principles of its application can find no place in the United States; secondly, that to attempt the substitution of its principles of control and operation within the States would be to strike a blow at economic structures, the present existence of which are not only far better equipped to protect the public interests in their conjunctive relation with the public service commissions of the States regulating their rates, but it would also be to strike an equal blow at the shareholders of the electric utilities which are now serving the American public; and, thirdly, that the Hydro-Electric Power Commission owes its being only to the fact that a public service commission on the order of those operating in the States was not in existence in the Province of Ontario at the time of its creation.

"I support the above statement in the following conclusions:

"(1) Power as applied in Ontario from the governmentally-owned and controlled system in associate relationship with the Hydro-Electric Power Commission to be superior in kind to that supplied by the privately-owned electric utilities of the United States must be more adequate,

more reliable and cheaper. The facts show, however, that the electric utilities of the States hold more power in reserve and sell more energy per capita served, that by that token they can claim a greater reliability of supply and that the supply is cheaper to the consumer.

"(2) At the end of the fiscal year 1920, out of the total power plant capacity operated by the Hydro-Electric Power Commission only 23% of it was constructed by the Hydro-Electric Power Commission; the remainder represents plant capacity constructed at the initiative and risk of private investors, and in acquiring ownership of it, such intangibles as franchise rights, good-will and other intangibles were included in the purchase. This intangible cost, therefore, is represented in power "at cost." If a governmental plan of like characteristics to that of the Hydro-Electric Power Commission is to be inaugurated in the United States, it must include the purchase of or the contracting of power from existing utilities and the same problem of including intangibles will be presented here.

"(3) The building of new power plant facilities under the auspices of governmental ownership, as shown in the cases of Nipigon and Chippawa, both in respect to policy and cost, is not to the economic interest of the people.

"(4) The advocates of government or municipal ownership of electric utilities claim reduction in the cost of power by virtue of: (a) Elimination of taxes; (b) Elimination of Dividends; (c) Elimination of high-salaried executives; (d) More economical wage and higher efficiency in labor scale.

"With regard to (a)—taxes are not eliminated. Just as much money in taxes is paid. The difference is in their distribution. In the case of private ownership, only the users of service pay the tax bill, while in the case of government-owned utilities all the people pay the bill.

"With regard to (b), (c) and (d), notwithstanding dividends, high-salaried executives and the wage and labor claim, the answer is, when the total operations are summed up, the people receive the power at less cost through private ownership under regulation.

"(5) The investment of capital in electric utilities under private interest control is far better protected from extravagance than when that capital is governmentally-owned, for the reason that plans and estimates for such capital expenditures not only must gain the approval of a trained engineering and managerial staff and an experienced board of directors of the company, but it also must have the critical review of the banker and the private financial investor. In the case of governmentally-owned utilities, the directing heads are seldom specifically trained in the business under their jurisdiction.

"Arms, legs and body are useless without the head. A high-salaried executive usually saves many times (his salary included) the losses incurred by the cheaper and less efficient executive. Accomplishment by individuals in control of private enterprise is under keener observation than is the case when those in charge are governmental or municipal officers.

"(6) Governmental ownership eliminates all incentive for gain and throttles initiative. This is evidenced by the far greater growth of privately-owned utilities.

"(7) The Hydro-Electric Power Commission is the judge of its own acts. A commission cannot fairly be the judge of its own (and others') rights in contentions.

"(8) Honesty of purpose does not necessarily reduce the power bill. The structure under which it is administered counts just as much—so far as the price is concerned.

"(9) The American companies in the Niagara district are supplemented by steam power far more than those on the Canadian side, and yet on the American side power is being furnished at less cost to the people.

"(10) The Commissions of the States fully realize that protection to the people lies in protection to the electric utilities from which they are receiving power. The authority delegated to them to regulate rates, and the constitutionality of the law standing behind any action on their part or on the part of the electric utilities, provides a structure constructively balanced to do justice to all parties."

TO INVESTIGATE ONTARIO HYDRO

Premier Drury, of Ontario, Appoints Royal Commission with Wide Scope for Investigation—Includes R. A. Ross and M. J. Haney

PREMIER Ernest C. Drury, of Ontario, has announced the appointment of a Royal Commission to investigate the cause of the increased estimates for the Queenston-Chippawa power development, and the general operation of the Hydro-Electric Power Commission of Ontario. The commissioners are:

W. D. Gregory (chairman), of Trafalgar, Ont., barrister.

R. A. Ross, of Montreal, consulting engineer.

M. J. Haney, of Port Credit, Ont., contractor and civil engineer.

Lloyd Harris, of Brantford, Ont., capitalist.

James A. Ross of Toronto, manufacturer.

The commission is to enquire into and report upon the following:

(1) All estimates submitted from time to time to the Hydro-Electric Power Commission of Ontario for the Queenston-Chippawa power development, and also all estimates for the said work submitted by the said commission to the Government of Ontario.

(2) The reasons for increases from time to time in the estimates for the Queenston-Chippawa power development.

(3) The total cost, when completed, of the Queenston-Chippawa power development (a) with five units installed; (b) with units installed to the full capacity of the canal.

(4) The continuous output capacity of the Queenston-Chippawa power development under the conditions mentioned in clause 3.

(5) The methods of construction, supervision and management which have been employed in the Queenston-Chippawa power development, and whether they can justifiably be continued for the economical completion of the work.

(6) (a) The quantity of water now available for use by means of the Queenston-Chippawa canal; (b) the power that can be developed thereby in continuous output at the Queenston power station.

(7) In what manner and to what extent will the price of Niagara power be affected, if at all, by the cost of the Queenston-Chippawa development?

(8) Any other power development undertaken by the Hydro-Electric Power Commission, and generally all matters of expenditure and administration by the said commission.

The commissioners are also to make such suggestions and recommendations arising out of the subjects indicated as they may deem desirable, and to report the evidence and facts brought out by the investigation.

Robert Alexander Ross, of the firm of R. A. Ross & Co., consulting engineers, Montreal, was born in Woodstock, Ont., in 1865. He was apprenticed to an engine-builder as a machinist for five years, and later was works engineer for the Canadian General Electric Co. for four years. He was chief engineer of the Royal Electric Co., Montreal, for three years. He had been a consulting engineer for 27 years on different projects in various parts of the world. He is a Doctor of Science, University of Toronto, and took his degree of electrical engineer at the University of Toronto. Mr. Ross is a past president of the Engineering Institute of Canada, and is Chairman of the Research Council of Canada. He was for four years a member of the Administration Commission, Montreal.

Michael John Haney, who is a well-known contractor, is also the president of the Home Bank of Canada, vice-president Canada Steamship Lines, vice-president Quebec Steamship Co., director North American Life Assurance Co., president Pointe Anne Quarries, Port Credit Brick Co., Reynolds Co. and Canada Bond Co. He was born in Galway, Ireland, in 1854, and came to Canada in 1873, being educated in Watertown N.Y. He was connected in an engineering capacity in the building of several railways, and was manager of construction of the C.P.R., 1883-87. He

was superintendent of construction of the Crow's Nest Pass Line, C.P.R., and has built several breakwaters and other structures for the Dominion Government since 1904. He built the intake tunnel for the Toronto waterworks in 1909. He is a member of the Engineering Institute of Canada. He has acted as arbitrator in several disputes.

J. Allan Ross is vice-president, treasurer and managing director of Wm. Wrigley, Jun., Co., Ltd., manufacturers of chewing gum. He was born in Chicago, February 11, 1886, and was educated in that city, and is a Bachelor of Science of the University of Chicago. He began his business career as night manager, Bell Telephone Co., Chicago, in 1907. He was university tutor in Chicago from 1907 to 1909, in which latter year he became associated with the Wrigley Co. He started the Canadian business in 1910 as manager.

Lloyd Harris is president of the Russell Motor Car Co., Ltd.; Underfeed Stoker Co. of America; Canada Glue Co.; vice-president of the Willys-Overland, Ltd.; Canada Cycle and Motor Co., Ltd.; Machine and Stamping Co., Ltd., director of the Massey-Harris Co., Ltd.; Steel Co. of Canada, Ltd.; Dominion Power Transmission Co.; American Glue Co.; Trusts and Guarantee Co.; British Foundation Ovens, Ltd. He is a member of the Honorary Advisory Council for Scientific and Industrial Research. He was formerly Canadian Trade Commissioner to Britain, and was vice-president of the Canadian Manufacturers' Association in 1905. He was a member of the House of Commons, as a Liberal, from 1908 to 1911, but left the party over the question of reciprocity with the United States. He was born in Beamsville in 1867.

W. D. Gregory, barrister, is head of the legal firm of Gregory & Gooderham, Toronto. He has already served on two other commissions for the Drury Government, the Public Service Commission and the Commission to investigate the Police Court and police force in the city of Brantford. He was born at Montacute, Somerset, England, and came with his parents to Canada when eight years of age, settling in Oxford county. Mr. Gregory, when 12 years of age, left school and worked on the farm in the summer and in the woods in the winter until he was 19, when he returned to school, passed his entrance and entered high school. Working again on the farm, at the age of 22, he returned to high school and matriculated. He was called to the Bar in 1887.

CONFERENCE ON COMMERCIAL ENGINEERING

CALLED together by the United States Commissioner of Education, the Second Public Conference on Commercial Engineering will be held at the Carnegie Institute of Technology, Pittsburgh, Pa., on May 1st and 2nd. The proceedings are under the direction of the Committee on Commercial Engineering of the United States Bureau of Education and include many addresses by notable engineers, educators and business men. Representatives of the Canadian universities are being requested to attend and take part in the deliberations.

The speakers at the conference include among others, the following: W. F. Rittman, Professor of Commercial Engineering, Carnegie Institute of Technology; Dexter S. Kimball, Dean of Engineering, Cornell University; P. F. Walker, Dean of Engineering, University of Kansas; R. L. Sackett, Dean of Engineering, Pennsylvania State College; D. C. Jackson, Professor of Electrical Engineering, Massachusetts Institute of Technology; H. R. Hatfield, Dean of the Faculties, University of California; F. B. Jewett, Vice-President, Western Electric Co., New York City; W. E. Mott, Director, College of Engineering, Carnegie Institute of Technology; C. R. Dooley, Director, Personnel and Training, Standard Oil Co., New York City; C. R. Mann, Chairman of Operations and Training Division, General Staff, War Department, Washington; Arthur E. Morgan, Antioch College.

The object of the convention is to investigate business training for engineers and engineering training for students in business. It is believed that not all has been done that might profitably be done in the matter of co-ordinating instruction in business and engineering in educational institutions.

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OPPORTUNITIES IN 1922

BABSON, the well-known economist of Wellesley Hills, Mass., says: "Every year has its opportunities. Great fortunes are made during periods of depression as well as during periods of prosperity. They, however, are made by different groups of people and in different ways. 1922 will offer wonderful opportunities, but they must be sought for. They will be found by the engineer rather than by the promoter, by the thrifty banker rather than by the speculator, and by the man who creates and upbuilds rather than by the middle-man or trader."

CANADIAN ENGINEERING STANDARDS ASSOCIATION JUSTIFYING ITSELF

WITH the publication of the standard specification for Portland cement mentioned elsewhere in this issue, the Canadian Engineering Standards Association has prepared and made available for the public five different standard specifications. These deal with steel railway bridges, distribution type transformers, galvanized telegraph and telephone wire, wire rope for mining and dredging purposes, and Portland cement. In view of the difficulties involved in creating for such work an organization of technical men working without remuneration, and in overcoming the inertia, and even opposition from certain quarters, the Association has achieved much in its existence of three years.

It has been tacitly assumed by some that the influence of American specifications on this continent would make it impracticable to devise anything different or original applying to construction in Canada. The Portland cement

specification is a clear answer to such an assumption. This document not only makes provision for the particular national conditions existing in this country, but at the same time in a number of ways constitutes a real improvement over the standard American specification, that prepared by the American Society for Testing Materials. There are sufficient experts in the manufacture, testing and use of cement in Canada to give our own views weight and authority. If in any particular we are able to devise specifications that are improvements on the American ones, we should by all means do so regardless of the fact that a certain advantage might accrue from international uniformity.

CONSERVATION OF ELECTRIC ENERGY

UTILIZATION of electric current which otherwise might be wasted is possible in many industries through the generation therewith of steam to be used either in cooking, drying, humidifying or heating of buildings. As was pointed out by F. T. Kaelin in a recent address given at a joint meeting of the Montreal Branch of the Engineering Institute of Canada, and the Montreal section of the Society for Chemical Industry and the Canadian Institute of Mining and Metallurgy, over three hundred installations of electric steam generators are known to exist in Italy, Switzerland, Sweden and France. Although the high price of fuel along with the low price of electrical energy particularly favors such installations in these countries, nevertheless a number of them have already been operated with success in Canada and the United States.

In any ordinary competition of electric energy with coal at reasonable prices, the electric generation of steam is entirely out of the running economically, by reason of the simple fact that the development of one heat unit by the use of electrical current costs a great deal more than the development of a heat unit by the burning of coal, even allowing for the large losses that occur in the latter operation. There are, however, many cases where electric power is paid for at a flat rate based upon consumption at peak load and where the current at off-peak would ordinarily be wasted. If, at the same time, fuel costs chance to be high the electric generation of steam may be practicable. The low capital expenditure incurred in the provision of electric generators, and the small operating charges involved in their operation, favor such procedure.

An interesting case of conservation brought about in this manner was in the case of a pulp and paper mill cited by Mr. Kaelin in which the saving of coal for heating effected on the fifty-two Sundays and three holidays during the year when electrical energy was not being utilized otherwise was more than sufficient to pay for the entire cost of installing the generator in less than one year. It is possible, too, that under temporary conditions of small power demand the power companies might find it advantageous to dispose of excess power at low rates for steam generation. This procedure would, of course, become impracticable as soon as power demands became normal.

The fact that the utilization of unused electric energy has been found commercially practicable in a number of cases in this country ought to encourage engineers in devising means of further conserving our electrical energy.

PERSONALS

D. F. DOWSLEY has been appointed road superintendent for the Township of Front of Escoff.

R. E. McDONNELL, architect, of Montreal, will form a partnership with F. W. WARREN, architect, of Hamilton.

JAMES F. McLAREN has been appointed assistant superintendent of the Island filtration plant, Toronto, Ont., to succeed the late Wm. Scott.

EUGENE LAPOINTE, consulting engineer of Baie St. Paul, Charlevoix County, Que., has been admitted to membership of the Corporation des Arpentiers-Geometres of the Province of Quebec.

GORDON L. SHANKS has just been appointed Municipal Engineer for Rockwood Municipality, near Winnipeg, Man. During the past year Mr. Shanks has been engaged on construction work in Mexico in connection with the Foundation Co.

WILLIAM P. HINTON, formerly vice-president of the Grand Trunk Pacific Railway, who was superannuated after thirty-five years' service on March 1 last, has been appointed vice-president and general manager of the Cadoman Coal Properties in the Rocky Mountain district, south of Edson.

C. H. WITHERS, who has been actively associated with Escher Wyss & Co. interests in Canada for the last nine years, and latterly attached to the staff of the General Supply Co. of Canada, Ltd., will sail next month for England, where he will be a member of the London staff of Escher Wyss & Co.

J. F. PARSONS and GILBERT T. ED, both of Moncton, N.B., have formed a construction company which will be known as the Parsons-Ed Co. Mr. Parsons has been following construction work for over 16 years, while Mr. Ed has been carrying on business as a general contractor in Moncton for several years.

FREDERICK T. KAELEN, chief engineer of the Shawinigan Water & Power Co., Montreal, who, jointly with Julian C. Smith, was in charge of the design of the inter-

esting extension to that company's hydro-electric plant at Shawinigan Falls, Que., described in "The Canadian Engineer" for March 14, 1922, was born on July 30, 1874, in Switzerland, and was educated at the Federal Technical University, Zurich. Mr. Kaelin came to Canada in 1902 and entered the employ of the Shawinigan Water & Power Co. as a draughtsman. From 1905-7 he was designing engineer on the staff of Wallace C. Johnson, consulting engineer, Niagara Falls. He then returned to the Shawinigan Water & Power Co. as assistant chief engineer, becoming chief engineer in June, 1919. Mr. Kaelin is a member of the Engineering Institute of Canada, the American Institute of Electrical Engineers and the American Society for Testing Materials.



OBITUARY

CAPTAIN LEWIS W. KLINGNER, of Toronto, was accidentally drowned in the river Tigris near Bagdad on April 2. Captain Klingner was a civil engineer connected with the Irak Irrigation Co., as officer in charge of surveys for Mesopotamia, with headquarters at Amara. The deceased was born in 1886 and educated at Harbord Collegiate Institute and Toronto University, graduating in 1907 from the School of Practical Science. He was connected with the Canadian Pacific Railway in an engineering capacity for a number of years and also with the Dominion Construction Co. In September, 1914, he enlisted with the Canadian Engineers and served in France with the 4th Division. Capt. Klingner was a member of the American Society of Civil Engineers and an associate member of the Engineering Institute of Canada.

Engineer's Library

CANADA CEMENT CO. ISSUES ATTRACTIVE NEW HOUSE ORGAN

NUMEROUS interesting articles, well illustrated, are contained in No. 1, Vol. 1, of "Municipal Improvements," a new house organ published by the Canada Cement Co., Ltd., Montreal. No definite announcement is made regarding the frequency with which "Municipal Improvements" will be issued, but it will probably be quarterly. The first issue, which is dated March, 1922, contains 24 pages and cover, 8 1/2 by 11 in., well printed on coated paper, with an attractive cover in colors, showing a view of the canal section of the Chippawa power development. The articles describe numerous interesting examples of concrete work in various parts of Canada, including the Chippawa development, St. Margaret's Bay power development, Peterborough bridge, Maryland St. bridge, St. John pipe-line, Point Grey school, etc. It also includes other interesting information, such as yardage of concrete pavements in the United States and the tentative construction program for the coming season for the Ontario Department of Highways.

FIRE PREVENTION AND FIRE PROTECTION AS APPLIED TO BUILDING CONSTRUCTION: A HANDBOOK OF THEORY AND PRACTICE—By Joseph Kendall Freitag, author of "Architectural Engineering," "The Fireproofing of Steel Buildings," etc. Second Edition. New York: John Wiley & Sons, Inc.; Flexible imitation leather; 4 by 6 1/2 in.; pp. 1037; illustrated; \$5.00.

Important changes and extensions have been made in this, the second edition of Mr. Freitag's handbook "Fire Prevention and Fire Protection." With the art developing at a rapid rate, it is manifestly necessary to revise the literature of the subject at frequent intervals, and the author has shown evidence of the desire to keep this work strictly up to date.

The principal revisions relate to design, construction and equipment, although extensive changes have been made in the chapters dealing with theatres and garages by reason of the fact that practice with respect to these classes of buildings has advanced very considerably since the first edition of the work was published.

Annual fire losses for the United States have not been tabulated subsequent to the year 1909, since their relative magnitude was very much obscured by the enormous national expenditure during the war period. It was thought that the normal relation of fire losses to the national budget would be better displayed by pre-war comparisons. The stupendous fire loss sustained is, however, clearly indicated in the fact that for the five-year period from 1915 to 1919 the annual loss in the United States was very nearly three hundred million dollars.

In the present edition references to comparative costs have in the main been omitted by reason of the fact that they fluctuate from year to year.

This work in its revised form furnishes a very convenient manual for those having to do with fire prevention and fire protection. Not only is the question of fire losses and their prevention discussed from a broad and basic standpoint, but a very large amount of practical data are given on fire tests of materials and their permanency. The design of the main structural elements of buildings, as well as of many details affecting fire resistance, is carefully discussed. Consideration of the fire aspect of various structures as a class, such as theatres, schools, factories, etc., form an important part of the work. Of value, too, is the discussion of auxiliary equipment and safeguards for the prevention and fighting of fire.

For architects and engineers concerned with the design and equipment of buildings this work is indispensable.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Prince Edward Island, Province of, grading and concrete structures	Apr. 28	Apr. 11
Prince Edward Island, Province of, road materials	Apr. 28	Apr. 11
Halifax, N.S., construction of three roads	Apr. 29	Apr. 18
Queenston Heights, Ont., sub-grading and construction of macadam road-way	May 24	Apr. 18
St. Thomas, Ont., construction of pavements	Apr. 28	Apr. 18
Welland, Ont., construction of water-bound macadam and bituminous penetration roads	May 1	Apr. 28
Petrolia, Ont., supply and construction of steel reservoir foundation and pump	May 1	Apr. 18
Calgary, Alta., supply of an electric arc welding outfit	Apr. 27	Apr. 18
Pridgewater, N.S., erection of Fire Hall	May 8	Apr. 18
Pembroke, Ont., erection of hospital	May 9	Apr. 11
Ontario, Province of, various work on Provincial highways	May 11	Apr. 11
Fort William, Ont., construction of school	Apr. 27	Apr. 18
Toronto, Ont., work on Riverdale Branch Technical School	May 3	Apr. 18
Vauxhall, Alta., erection of school building	May 1	Apr. 18
Adamsville, Que., construction of concrete bridge	May 1	Apr. 18
Crystal Beach, Ont., sewer and disposal plant	May 5	Apr. 18
Phillipsburg, Que., gravelling of road.....	May 1	Apr. 18
St. Andrews, Man., maintenance of roads	May 1	Apr. 18
Toronto, Ont., construction of Gerrard St. bridge	May 16	Apr. 18
Guelph, Ont., manufacture and delivery of sewer pipe	Apr. 27	Apr. 18
Guelph, Ont., supply of Portland cement	Apr. 27	Apr. 18

BRIDGES, ROADS AND STREETS

Brantford, Ont.—Tenders will be received by Alan Blair Jackson, Brant County Engineer, Court House, until 5 p.m., Tuesday, April 25, for the supply of an estimated amount of 6,000 barrels of cement in carload lots for the season 1922.

Cameron R.M., Man.—Tenders addressed to T. B. Woodhull, Sec.-Treas., Hartney, Man., will be received until 12 o'clock noon, April 29, for the grading of nine miles of road. Also for the manufacture of concrete pipe culverts required on 38 miles of road. Specifications may be obtained at the office of the Highway Commissioner, Parliament Buildings, Winnipeg, or at the office of the Secretary-Treasurer, Hartney, Man.

Escott, Ont.—Council of Front of Escott Township passed a by-law to provide \$3,000 for construction and \$7,

500 for maintenance of township roads. Clerk, Ernest C. Kelly, Mallorytown, Ont.

Francis, Sask.—Tenders addressed to S. Mars, Sec.-Treas., will be received until 6 p.m., May 5, for all or parts of the following work: Sixty miles of blade grader work, 25,000 cu. yds. grading and 1,200 lin. ft. of pipe (placing and hauling). Plans and specifications may be seen at the office of the Municipal Engineers, Parsons Engineering Co., Regina.

Halifax, N.S.—City Council awarded contract for construction of pavement to Victor Osterburg.

Halifax, N.S.—Representatives of city and Highways Commission will hold a conference regarding the proposed improvement of the Dutch Village Road.

Halifax, N.S.—Provincial Highway Board received tenders from following for construction of Bedford-Waverley road: McDonald Construction Co., Ltd., Engineers & Contractors, Ltd., J. M. McGrath, W. J. Stuart, Naugle, Hiltz & Conrad, Terminals Construction Co., McNab Construction Co., Ltd., Fraser Paving Co. and Provincial Highways Board. It was decided by the Board to carry on the work by day labor under the Board's officials.

Halifax, N.S.—Provincial Highway Board received tenders from following for construction of Irish Cove-Big Pond road: Chisholm & MacMillan, Nova Scotia Road Builders, Engineers & Contractors, Ltd., William Cooke, E. A. Cranston, Provincial Highways Board, John L. Sexton and Charles McKenzie, Nova Scotia Construction Co., Ltd., Graham & MacKay and Israel, McKenzie Bros. & Cunningham. Board decided to carry this work on by day labor under Board's officials.

Halifax, N.S.—Tenders were received from the following by the Provincial Highway Board for the construction of the Kenzieville-Pictou Antigonish County Line road: W. J. Stuart, Chas. McNeil, John Fraser, A. J. Bannerman, Fulton Bros., Chas. Sproull, C. D. Chisholm, Terminals Construction Co., Provincial Highways Board, Williams Bros. E. P. Power and P. Meikle submitted a combined tender, as did also the following firms: Chas. A. Mitchell, A. R. McDonald, T. J. Sears and T. J. Bonner. Contract was awarded to W. J. Stuart, Yarmouth North, whose tender was the lowest received.

Hamilton, Ont.—City Council adopted recommendation for the construction of a sidewalk on the south side of Concession St., from Wentworth St. to Albert St. City Engineer, E. R. Gray.

Hamilton, Ont.—City Council approved the paving of Wentworth St., from King St. to the T. H. & B., and Cumberland Ave., from Gage to Sherman Ave. Petitions were received for the paving of St. Clair Ave. and Eastbourne Ave., from Cumberland Ave. to the T. H. & B. railway.

Hamilton, Ont.—Wentworth County Council made the following appropriations for road work this year: Ninth Concession, \$1,500; Jerseyville, \$4,000; Brock, \$5,000; Sydenham, \$1,000; Dundas, \$19,900; Port Plamboro, \$7,000; Blinbrook, \$25,000; Governors, \$8,000; Mohawk, \$2,000; Green, \$2,400; Kirkwall, \$700; Copetown, \$3,000; Glanford and Blinbrook, \$3,000; Barton St., \$4,200; Tapleytown, \$7,700. Supt., T. R. Allison, Hamilton.

Kitchener, Ont.—Tenders will be called for the construction of asphalt pavements on the following streets: King, from Albert to Hmlts; Frederick, from King to House of Refuge; Wilnot, from King to Strange; Queen, from Ellen to Lancaster; Linden, from Joseph to Michael; Gaukel, from King to Joseph, Victoria from Ahrens to Lancaster; and Weber, from Brethaupt to G.T.R. tracks. City Engineer, S. Shupe.

Leamington, Ont.—Contract for construction of 2½ miles reinforced concrete pavement with curbing and catch basins have been awarded to the Chick Contracting Co., Ltd., Windsor, for approximately \$85,000. Tenders were also received from the following firms: Archibald Construction Co., Ltd., Toronto; Pettipiece's, Ltd., Amherstburg; Cadwell Sand & Gravel Co., Windsor; S. P. West, Sandwich; B. Oldoni, Windsor; McNamara Bros. & Thornton, Sault Ste. Marie; Johnson Bros. Co., Ltd., Brantford; L. J. Looby, Dublin, Ont.; F. Smithson, Leamington; Campbell & Latimore, Toronto; Hamilton Contracting Co., Hamilton; Oakwood Construction Co., Windsor; Merlo, Merlo & Ray, Ltd., Walkerville.

London, Ont.—Bridge Committee of Middlesex County Council awarded following contracts: Culvert at Strathroy, Isaac Drake, at \$1,122; rebuilding Muncey bridge, steel work, W. J. Reader, Alvinston, \$2,049; concrete work, E. Kelly, Lambeth, \$2,090. Caradoc and Ekfrid bridge, concrete work, C. Ferguson, Melrose, \$860; steel work, W. J. Reader, Alvinston, \$399. Caradoc, two bridges, I. Drake, Strathroy, \$1,593. Bridge in East Williams, I. Barons, Nairn, \$915.

Maple Ridge, B.C.—Municipal Council has made arrangements to open up and extend the Jackson Road East to Spillbury Road, and construct bridges, one across a ravine 1,200 ft. long. Clerk, J. C. McFarlane.

Nanaimo, B.C.—The South Forks bridge is to be rebuilt at a cost of about \$7,000, the Provincial Government to pay half the cost. Minister of Public Works, Hon. W. H. Sutherland.

Niagara Falls, Ont.—New tenders on asphalt paving plant of 1,250 sq. yds. capacity were opened on the 18th inst. and contract awarded to Barber Asphalt Co. "Iroquois Plant." Following bids were received on a 1,250 steam melting, oil burning, semi-portable plant without power or boiler: Barber Asphalt Co., \$14,572; Hetherington & Berner, \$15,090; F. D. Cummer & Son Co., \$15,775; Warren Bros., \$12,950; Dominion Industrial Products Co., Ltd., \$13,014.78. All tenders in Canadian funds for plant erected and in running order; duty paid.

Oakville, Ont.—At the next meeting of the Town Council a by-law to provide for a program of road construction will be brought up. Petitions for concrete walks on four streets will also be received. Clerk, Percy A. Bath.

Ottawa, Ont.—At the next meeting of the Town Planning Commission the widening of Besserer St., between Sussex and Mosgrove Streets, was discussed; also the widening of Mosgrove St. to 80 ft.

Owen Sound, Ont.—City Council decided to construct a concrete road on 2nd Ave. E., from 12th St. to 14th St. Clerk, Chas. Gordon.

Palmerston, Ont.—Wellington County Council plans paving of several streets here. Road Supt., John M. Young, Harriston.

Quebec, Province of.—An inspection of the projected Quebec-St. Ann Highway will be made shortly by engineers of the Department of Roads, after which tenders will be asked by Hon. J. L. Perron, Minister of Roads.

Quebec, Province of.—Contract for the Montreal-Mont-Laurier highway was awarded by Provincial Department of Highways to Frank Walter & Co., for \$181,000. The highest tender received totalled \$373,000. The construction work on this contract is divided into two sections, four miles from Janvier to Ste. Therese and 21 miles north of St. Jerome.

Quebec, Province of.—New tenders are being called by the Hon. J. L. Perron, Minister of Roads, for the construction of sections of the Montreal-Sherbrooke and St. Lambert-Levis highways. Those already received were considered too high and were rejected. The section of the Montreal-Sherbrooke highway to be constructed is about 27 miles long. The St. Lambert-Levis highway is about 23 miles long and runs from St. Lambert to Sorel.

Revelstoke, B.C.—Provincial Public Works Department will start work on May 1 on construction of uncompleted two miles of the Revelstoke-Taft link of the Revelstoke-Vernon highway.

St. Catharines, Ont.—Lincoln County Council awarded contracts to the Law Construction Co., Toronto, and Roy Haesberger, Vineland, Ont., for the supply of material and construction of bituminous penetration and macadam roads, and to McIntosh & McDougall, Cornwall, for material and construction of macadam road.

St. John, N.B.—Common Council decided to call tenders for 1,875 lin. ft. of straight curbing and 144 ft. of circular curbing for Waterloo St. Estimated cost, \$5,300.95.

St. Joseph de Chambly, Que.—Tenders were received at the office of L. J. E. Brais, Sec.-Treas., County of Chambly, 130 Chambly Road, Longueuil, Que., until April 22, for the construction of a bridge on Chambly Road, Parish of St. Joseph de Chambly.

Shuniah, Ont.—By-law will be submitted to ratepayers on May 13 to authorize the borrowing of \$10,000 for the construction of roads in the Township of McIntyre. Clerk, H. A. McKibbin.

Toronto, Ont.—City Council referred back the matter of a lane south from College St., between Roxton road and Ossington Ave., for two weeks.

Toronto, Ont.—City Council intends to construct curbing on Hiawatha Road at a cost of \$498, and asphaltic concrete pavement at a cost of \$9,838.

Victoria, B.C.—Provincial Department of Public Works will shortly call for tenders on four or five classes of work in connection with the paving of about three miles of the Pacific Highway, including concrete, Tarvia, macadam and bitulithic. Minister, Hon. W. H. Sutherland.

York Tp., Ont.—Call for tenders for construction of six reinforced concrete culverts has been recalled.

WATER, SEWAGE AND REFUSE

Barton Tp., Ont.—A scheme to install water and sewer connections in the township at a cost of about \$239,000 was outlined by the Mountain Improvement Society at a recent meeting of Barton Township Council.

Bridgeburg, Ont.—Bridgeburg and Fort Erie Councils considering construction of joint sewer in Amigari section at cost of \$40,000.

Chatham, Ont.—Tenders will be received for the supply and construction of steel sheet piling baffling system in water works sedimentation basin up to 5 p.m. Wednesday, May 10. Plans and specifications may be obtained at the office of the City Engineer. Address tenders to the Secretary Board of Works Commissioners, Chatham, Ont., endorsed "Tender for Sheet Piling." C. H. R. Fuller, City Engineer. (See official advertisement).

Hamilton, Ont.—Contract for construction of Section No. 3, Western storm overflow sewer, awarded to J. H. McKnight Construction Co., Ltd., Toronto, at \$192,700.

Midland, Ont.—Construction of approximately three miles of sewers, for which tenders were called, is being carried out by day labor.

Oshawa, Ont.—Board of Works recommended to Town Council that contract for completion of Base Line sewer to the Central Foundation Co. of Toronto, for approximately \$17,000, material for work to be supplied by town.

Ottawa, Ont.—Contract for supply of vitrified clay sewer pipe was awarded to Barrett Bros., of Ottawa, for a term of three months dating from signing of contract, the total amount of their contract being \$18,030. Four tenders were received, two for concrete pipe and two for vitrified clay pipe. The other tenders received were: T. S. Kirby Co., Ltd., Ottawa, vitrified clay pipe, \$18,108; Independent Concrete Pipe Co., Ltd., Toronto, concrete sewer pipe, \$18,768.70; Dominion Concrete Co., Kemptville, concrete sewer pipe, \$8,590. The latter firm did not quote on all the items in the tender form. Both Barrett Bros. and the T. S. Kirby Co., Ltd., bid on Standard Clay Products, Ltd., pipe.

Toronto, Ont.—City Council intends to construct a water main on Cranbrook Ave., at a cost of \$3,063.

Toronto, Ont.—Board of Control decided not to grant the application of the Township of York for an increase in the supply of water received from the city's system.

Toronto, Ont.—A recommendation was made to Board of Control by Street Commissioner Wilson that a piece of land, south of the railway tracks, just west of Dufferin St., be purchased as a site for an incinerator plant.

LIGHT, HEAT AND POWER

Brockville, Ont.—Work has commenced by the Hydro-Electric Power Commission of Ontario on the construction of a new line on the St. Lawrence system between Morrisburg and Brockville.

Niagara Falls, Ont.—City Hydro Commission let contract for new sub-station to the Robertson Construction Co., of this city, at \$67,190.

Paisley, Ont.—A Hydro power line will likely be constructed from Chesley to supply Paisley.

RAILWAYS

Fort William, Ont.—Tenders for Street Railway track construction, addressed to the Chairman of the Public Utilities Committee, will be received by the City Clerk, until 5 p.m., Monday, May 1. Specifications at office of A. L. Farquharson, Manager of Street Railway.

Toronto, Ont.—Board of Control held a special conference with the local Hydro-Commission and the Transportation Commission to discuss the installation of a new connection with the Hydro system for supply of power for the Street Railway after September 1, when the agreement with the Toronto and Niagara Power Co. expires. This action has been taken so that the Street Railway will not be left without power in case the "clean-up" deal is not consummated.

FACTORIES AND LARGE BUILDINGS

Almonte, Ont.—Contract for erection of convent awarded to A. C. Gilmour, for \$14,140.

Barton Tp., Ont.—An early move is anticipated on the part of Barton township trustees to again revive the plan of building a new school on Concession St., mountain top, upon the site owned by the Board of Education.

Barton Tp., Ont.—A meeting of Barton Township School Section 3 ratepayers was held for the purpose of authorizing the issue of debentures for additional school accommodation. The resolution at the last annual meeting calls for the building of an 8-room addition to Lloyd George school, a 2-room addition to Brantdale school and a separate 4-room unit at Wellington St.

Berton, Man.—Contract for school awarded to John Mowat, of Gladstone, Man., at \$4,100.

Birch Cliff, Ont.—Contract for excavation of the new High School was awarded to Torrance Weir, of Agincourt, at 60 cents a yd. Contract calls for the removal of 3,000 cu. yds.

Bolton, Ont.—Plans for the erection of a new Town Hall at a cost of \$5,000 were approved by Town Council. Clerk, F. E. Snider.

Bridgeburg, Ont.—School Board let contract for construction of a four-room addition to the Wintermute Street school, to Somerville & Dilworth, of Welland, at \$2,212. The entire cost will be about \$30,000.

Bury, Que.—Catholic Board of School Commissioners considering erection of school.

Clarkson, Ont.—It is announced that the erection of a plant on the Dundas highway is under consideration by a rubber company. Address E. A. Orr, Reeve of Toronto Township.

Catharines, Ont.—Ratepayers passed by-law authorizing council to provide \$30,000 for erection of High School.

Delhi, Ont.—By-law, providing for the issuing of debentures amounting to about \$15,000, to cover the cost of constructing the proposed continuation school wing to the present public school, will be submitted to the ratepayers on April 26.

Edmondville, Ont.—Tenders will be received, addressed to W. J. Finnigan, Secretary, until Saturday, April 29, for the building of a new brick schoolhouse.

Fort William, Ont.—Tenders will be received at the office of A. McNaughton, city clerk, until 5 p.m., Tuesday, May 2, for placing a tar and gravel roof on the south half of the Central Fire Hall, Brodie St.

Kingston, Ont.—A building will be erected at a cost of \$300,000 to be used as a vocational training school.

Kingston, Ont.—Plans have been prepared for the new Eastern Ontario Dairy School. Address Prof. L. A. Zufelt.

Lambton, Ont.—Tenders addressed to J. H. Dicken, Secretary, Board of Education, S. S. No. 33, York, 43 Eileen Ave., Station D, West Toronto, will be received until 12 o'clock noon, Monday, May 1, for the erection of a four-room addition to the Lambton Park School. Plans and specifications may be obtained at the office of Smith & Wright, architects, Dominion Bank Chambers, 2945 Dundas St. West, Toronto.

Levis, Que.—Fire damaged the factory building of Cote & Jean, Commercial St., to the extent of \$15,000.

London, Ont.—The Tecumseh Amateur Athletic Association is behind a scheme to construct an artificial ice plant at a cost of \$80,000.

Metiskow, Alta.—Work will shortly start on the erection of a school. Also on the erection of new municipal offices.

Mimico, Ont.—Following contracts awarded in connection with erection of 6-roomed school: General contract, Wickett Bros., Toronto, \$45,449; electrical, Warner & Fordey, Mimico, \$1,070; plumbing and heating, James Millen & Co., \$10,174.

Montreal, Que.—Notre Dame Convent was destroyed by fire. Loss, \$150,000.

Montreal, Que.—Work has started on the construction of a four-storey addition to the office building of the Great West Life Assurance Co.

Montreal, Que.—Construction of three schools is being considered by the Protestant Board of School Commissioners. An extension to the Royal Arthur School is also on the program of the Board for this season.

Montreal, Que.—Sketches for the construction of the City Hall will shortly be completed. They will show first the use of the old building, and secondly, the construction of a new building on the old site. The amount available for the work is \$1,500,000.

Montreal, Que.—Tenders for the erection of the Notre Dame Hospital on Sherbrooke St. East, will be received at the office of Stevens, Lee & A. H. Lapierre, Associated Architects, 30 St. James St., until noon, May 15, for the concrete, steel work, masonry, brick work, roofing, sashes, etc., required to carry up and enclose the buildings.

Montreal, Que.—Following contracts were awarded for 12-room extension to Royal Arthur School on Canning St., by Protestant Board of School Commissioners: General contract, Nicholson Construction Co., Ltd., \$112,179; plumbing heating and ventilating systems, D. A. Bethune, Ltd., \$30,300; electrical work, Vincent & Say Electric Co., \$3,750.

Murrayville, B.C.—At a recent meeting of the Langley Council a large deputation presented a petition asking that a school be built at the corner of Hunter and Robb roads.

Nepean Tp., Ont.—New school will likely be erected. Clerk, John Gamble, Westboro.

New Toronto, Ont.—By-law providing for the purchase of a school site will be submitted to ratepayers.

Oakville, Ont.—Plans for the new \$25,000 Sunday School, proposed for the Oakville Methodist Church, have been approved by Board of Trustees. Campaign for funds will start beginning of next month.

Orangeville, Ont.—Orangeville Arena Co., Ltd., plan erection of skating rink, work to start immediately.

Ottawa, Ont.—Westboro-Nepean High School Board plan erection of High School. Tenders will be called shortly.

Ottawa, Ont.—Bulk or separate tenders will be received by the Public School Board until 12 o'clock noon, Thursday, April 27, for the several works required for the erection of additions to Cambridge St. and Glashan Schools.

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Water Works System at Richmond Hill, Ont.

Eight Million Gallon Capacity Reservoir—Old Earth Dam Rebuilt With Concrete Core Wall — Filters and Pumps in One Building With Coagulation Basin Adjoining and Clear Water Reservoir Under Pump House

By G. H. BAKER

Resident Engineer for James, Proctor & Redfern, Ltd.

CONSTRUCTION of the waterworks system for the village of Richmond Hill, Ont., was started in the fall of 1921. The supply of water is conserved by reclaiming and building up an abandoned earthen dam, and so holding back a stream of considerable flow, to create a storage

with a topography possessing natural advantages for creating a reservoir, and across the mouth of which has been rebuilt the historic dam. This old retaining wall is 400 ft. long, about 12 ft. high at the highest point, and has a roadway across the top averaging 30 ft. wide.

Construction of Dam

Tenders having been called for the work, a contract was let to Reid & Somers, of Guelph, Ont., to reconstruct the dam and build the filtration plant. To put the old wall into a serviceable condition, it was first necessary to make it water tight. To do this, a concrete core wall of 1:4 mix with gravel, was poured, stretching completely across the site and directly in front of the original dam, over which an earth fill with a slope of 2:1 was made to form the face of the wall. The trench for the core wall



GENERAL VIEW OF SITE, SHOWING PUMP HOUSE, EARTH DAM AND CULVERT

basin of large proportions. Dating back to the days when the district was an active and prosperous lumbering centre, this stream, which winds its way through the outskirts of the village about a mile west of Yonge Street, was dammed by the pioneers with an earthen wall, in order that they might secure power for manufacturing their forest products. But the forests were cut down and the lumbermen were forced to move northward to obtain a new supply of timber, leaving this example of pioneer engineering work to gradually fall into ruins. Many years afterwards, around this same spot, a modern waterworks system was built by repairing the old earthen dam, building a sluiceway or overflow outlet, constructing a pump house and filtration plant and erecting an elevated tank. From this supply system about four miles of distribution mains were laid throughout the village, delivering the supply of water for drinking and for fire protection.

The stream had its origin in springs about three miles to the north and with its minimum flow of 330,000 gallons per day, delivers a very generous supply for a village of this size. It flows down through a small valley or basin,



VIEW SHOWING CORE WALL BEFORE EARTH FILL WAS MADE

was about 8 ft. wide and was dug out of the soft marsh soil by a Keystone excavator. Excavation was carried down to a strata of gravel which was struck about 5 ft. below pond level, and which gave an excellent footing to the wall. The whole bottom of the trench was covered

with a layer of concrete 12 in. thick, on which the wall proper rests. The wall is 10 ft. high, measures 12 in. across the top and 3 ft. at the bottom, both sides being battered. As its purpose is to prevent seepage and not to take stress, no reinforcing is necessary. To pour the

mits the drainage of the reservoir when necessary.

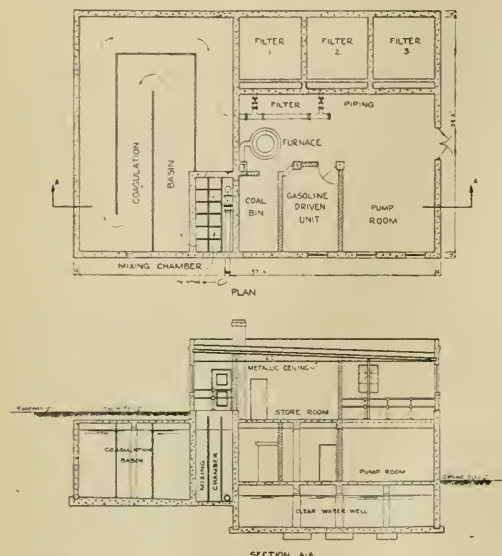
Situated on the low land back of the retaining wall, is the filtration plant and pump house, a compact and substantial building, measuring 59 ft. by 40 ft. over all, of reinforced concrete and brick construction, with steel sash and 4-ply tar and gravel roof. The working parts of the plant are located at an elevation below that of pond level, so that the water flows from the 10-in. intake pipe, running out into the pond to the mixing chamber and coagulation basin, through the filters to the clear water well below, by gravity. Below natural ground elevation we have the clear water reservoir, then at ground level are the mixing chamber, coagulation basin, filters, piping for filters, heating plant and pumps, while the upper floor, which is at the same elevation as the roadway over the dam, comprises the office, operating gallery for the filters and alum storage room. The building is efficiently heated by a Pease pipeless hot air furnace.

Coagulation Basin

The coagulation basin takes up the front section of the building and is built with 12-in. thick floor walls and an 8-in. roof, all heavily reinforced. The roof is 18 in. below the roadway over the dam, and is covered over with an earth fill, in order that the temperature of the water might not be greatly effected by the atmospheric temperature. The fill runs out to the dam proper, and so makes this roof as part of the roadway. The sedimentation basin measures 26 ft. by 40 ft. and is divided into four longitudinal sections by partitions 3 in. thick, of concrete plastered on metal "Hyrib," set in a groove left in the floor and ceiling for same. This creates a passage way 140 ft. long, 6 ft. wide and 12 ft. high, through which the water flows during the sedimentation period.

The mixing chamber is a concrete box 6 ft. by 12 ft. partitioned off in one corner of the sedimentation basin by a 12-in. wall, which is again divided into three longitudinal sections, by 3 in. concrete partitions. The 10-in. inlet pipe from the pond leads to the first of these sections, and the incoming water is checked by a float valve, adjusted to keep the water at such an elevation in the coagulation basin, that will assure a head of 2 ft. on the inlet pipes to the filters. The orifice tank also discharges the alum solution into this section. The other two sections contain the baffle boards, which thoroughly mix the alum and water.

Along the east side of the building, three filter beds have been built, each 10 ft. square, designed to filter 200

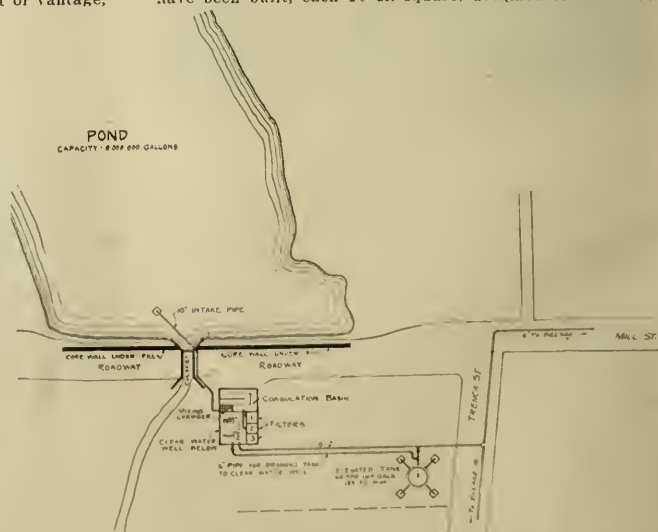


PLAN AND CROSS SECTION OF COAGULATION BASIN AND PUMPING

concrete in the forms the old retaining wall was an excellent natural platform for the mixer. It was placed about mid-way on the wall, and above it a large wooden bin was built for holding the gravel, with a chute running to the hopper. The gravel was teamed and dumped at the foot of the dam, raised from there in a bucket on a steam derrick, and dumped into the wooden bin. After being mixed, the concrete, from this high point of vantage, could be run in wooden chutes to the forms of the core wall below.

When the wall was completed it was covered up with an earth fill, forming the front of the dam. The material used is a light clay, secured by cutting into the side of a neighboring hill, and teamed to the site. The fill runs out from the original wall at the old road level, to a front 3 ft. north of the core wall, and then slopes down at 2:1 to the floor of the pond, and required some 2,600 cu. yds. of material. This makes a substantial and permanent retaining wall, creating a reservoir of eight million gallons capacity an area of 8 acres. It was necessary to clean the pond of tree stumps and other debris before stemming back the stream.

In providing an outlet or overflow from the pond, a sluice way or culvert was constructed midway across the dam, of the type now generally used in small highway bridges. This culvert has a span of 10 ft., and is designed with a concrete floor in the water way, so that the fall from the overflow might not undermine the footings. Where the wing walls join the main wall on the pond side, a concrete bulk head has been built 4 ft. high, above which slots in the concrete walls allow the placing of 8 in. by 8 in. wooden stop logs, to govern the elevation of water in the pond. At the base a 12-in. pipe and shear gate per-



GENERAL LAYOUT SHOWING POND, DAM AND FILTRATION PLANT

gallons per minute, per unit. Two of these are being equipped at the present time by the Pittsburgh Filter and Engineering Corporation. A layer of gravel 12 in. thick is being laid over the collectors, with 30 in. of sand, 98% silicious material, of a grain size ranging from .40 to .46 millimeters, on top.

Pumps and Tank

Two pumps have been installed, both supplied by the Northern Foundry & Machine Co., of Sault Ste. Marie, Ont. The service pump is designed to deliver 250 gal. per minute against a head of 150 ft. and is run by a 550 volt, 20 h.p. squirrel cage, Westinghouse motor. For fire service, a 500 gallon per minute, 250 ft. head, pump is used, driven by a 100 h.p. Sterling heavy duty gasoline engine.

An elevated tank of unusual height was erected, situated on the same lot as the pump house. From the base of the riser, a 6-in. pipe leads to the clear water well, and by opening the valve the tank can be drained back to the clear water reservoir. This is done when the tank is cut off to give fire pressure, and so increases the fire reserve by the contents of the tank. It was erected by the Canadian Des Moines Steel Co., of Chatham, Ont., is 135 ft. high and holds 60,000 gallons; no leaks developed when tested. It provides a domestic pressure in the village ranging from 40 to 60 lb. per sq. in.

Distribution System

The distribution system consists of 2,593 ft. of 10-in. pipe, 1,658 ft. of 8-in. pipe, 15,263 ft. of 6-in. pipe and 1,944 ft. of 4-in. pipe. The 10-in. and 8-in. mains are used as a main feeder from the pump house to the central part of the town, with the 6-in. mains branching off to serve the different streets; 25 valves being placed and



WEST ELEVATION—PUMP HOUSE AND FILTRATION PLANT

39 hydrants set throughout the system. The F. F. Fry Construction Co. were the contractors for laying the pipes, and did so without having a leaking joint. The only trouble arose from two cracked lengths of 10-in. pipe. The trenching was done by pick and shovel and the filling by a mechanical backfiller.

Cost of System

Construction was started during the second week of August, 1921, and though the plant was not entirely completed, water was supplied to the village on January 31, 1922. The cost of the system includes the following amounts: Pump house and filtration plant, \$16,293; rebuilding of dam, cleaning site of debris, and building culvert, \$10,234; elevated tank, \$8,900; tank footings, \$1,000; filter equipment, \$6,600; pumps, \$5,260; cast iron pipes, \$26,500; laying cast iron pipes, \$12,000; valves, and hydrants, \$3,500. Total, \$90,287.

W. B. Redfern, of James, Proctor & Redfern, Ltd., was engineer in charge of the work. The Council of Richmond Hill, who inaugurated the scheme and were re-elected by acclamation to complete the work, are Reeve, Thos. Trench; Councillors, D. Hill, J. Lunan, J. Batty and J. Monkman.

ENGINEERING IN INDUSTRIAL LIFE

EWART G. HOLMES delivered an interesting address on "Industrial Engineering Service" before the Rotary Club Montreal, recently. Dealing with the function of the modern industrial engineer, the speaker stated that the popular conception of an engineer was that of a man who has the knowledge to design works of large magnitude, while the plans of a building are the function of an architect. The part of the industrial engineer is to close the gap between the two. He must necessarily be an architect, capable of designing and laying out an economical building, and he must also know completely the latest practice of design in lighting and heating. Nor is this all, for he must also be familiar with the scientific requirements imposed by the process of manufacturing.

The development of industry in the last decade has been of a highly competitive and efficient nature. The manufacturer has been forced to give more of his time to economical manufacture of his product, to financing, to credit and sales. This has forced him to seek outside assistance in solving his problems. As a result of this demand there have grown up within recent years organizations which were perhaps primarily architects, possibly primarily engineers, but which have equipped themselves to furnish the manufacturer such assistance as he needs from the point of view of economy of management.

GOVERNMENT HAS NOT CONSIDERED WATERWAY PROJECT

REPLYING to the delegation representing the Montreal Board of Trade, the Shipping Federation and the cities of Quebec and Hull which waited upon protesting against the St. Lawrence-Great Lakes scheme for navigation of ocean boats, Hon. W. S. Fielding acting Premier said the question was important nationally, internationally and financially.

"If you are laboring under the idea that the estimates this year will contain twelve hundred million for this work, I can at once relieve you," he went on. "There is a divided opinion on this project in the States as in Canada."

"The problem has not yet been considered by the Government. I will not say the Government is hostile. If our neighbors want it, the proposals will be fully considered. There will be ample time, however, to receive the representation of all bodies and all currents of view in regard to the principle."

COMMITTEE TO EXAMINE FREIGHT RATES

J. CLARK REILLY, executive secretary of the Association of Canadian Building and Construction Industries, has issued a circular to members of the Association, drawing attention to a recent speech of the Minister of Railways and Canals in which reference was made to the question of freight rates. From a statement made by the Minister, it appears that the Government feels that the matter is of such importance to the people of the country that the entire question should be placed before the members of Parliament in such a way as to enable them to obtain the fullest possible information. The Minister proposes at an early date, to ask the House to appoint a special and representative committee to examine into the question of rates, with power to summon the executives of the various railways and others to place before the committee all available information for the consideration of the members.

Resolutions endorsing the construction of the Water-ton Lakes Reservoir and favoring a Bureau of Standards, were passed at a meeting of the Lethbridge branch of the Engineering Institute of Canada, held recently in Lethbridge, Alta. An interesting address was also given by John Dow, plant chief, of the Alberta Government Telephones, on "Modern Telephone Engineering."

COST KEEPING ON HIGHWAY CONSTRUCTION*

Still in Formative Stage — Some Excellent Systems in Operation — Classification of Cost Keeping Terms Wanted — Basis for Cost System

By A. R. Losh,

Asst. Chief of Construction, U. S. Bureau of Public Roads

FROM an extensive investigation made about six years ago by the Bureau of Public Roads it was found that generally very little cost keeping was done by state and county highway departments on highway work. Where practical and efficient cost keeping existed it was usually found to be on work done by the state highway departments. There was at that time very little interest manifested by public officials in cost keeping on highway work. A similar condition with respect to cost keeping existed to a large extent among road contractors. At this time there had been a long period of almost uniform conditions with respect to labor, materials, types of construction, and processes. The successful contractor had grown up in the business and had rules and methods of his own for estimating, which were based on years of experience and he did not feel the need of cost statistics. The greater portion of the highway work of the time was done by the type of contractor referred to as having his hat for his office and his check book for his cost record of the job. The more substantial contracting organizations and especially those which did not confine their operations to road work exclusively, carried cost keeping records on their road work. As a rule highway engineers attempted to obtain the costs on contract work but generally did not give sufficient attention to the details of cost keeping to obtain complete and reliable data.

It has developed from a recent preliminary study of highway cost keeping conditions that there has been a substantial improvement since the investigations previously referred to were made. In recent years, due to a scarcity of contractors in the highway field, it has been necessary for states and counties to do a large amount of highway work with day labor forces and the value of cost keeping as a check on expenditures and as a guide to efficient management has led to the installation of cost keeping of some kind on this work. In addition to serving these ends, much valuable cost data have been accumulated which form an important part of the fiscal records of the work and have also been used advantageously in placing other work under contract. The advantages of keeping cost of day labor work are generally recognized but there are divergent views with respect to keeping costs of contract work. As a result it will be found that with one state highway department cost keeping of contract work is incidental to the inspection and the resident engineer or inspector is to considerably extent left to his own devices in this regard, while with another state highway department the cost keeping is one of the important functions of the residency and not considered a sideline by any means.

When the cost of contract work is considered advantageously the method followed is either to select the jobs which will supply the information desired or to cover the entire program and keep costs of all contracts. In either case there should be a sufficient force available to handle the inspection and cost keeping properly. It will be difficult if not impossible to secure satisfactory results unless the inspectors or cost keepers receive specific instructions as to what they are to do, are supplied with standard recording and report forms, and their cost keeping supervised as well as their inspection work. It is not meant to infer that cost keeping is of the same importance as the inspection of the construction, but that if cost keeping is to be carried out at all it should have more than casual attention from the administrative authorities.

The advantages resulting from keeping costs on contract work are usually given as follows:

2. The department has available necessary cost data for making settlement with contractor where unforeseen conditions are involved.

3. Engineers and inspectors receive training in use of cost data and making up of estimates.

4. Provides a means for analyzing cost of work which may lead to development of more economical designs and methods.

5. In some cases of assistance to the contractor who may not even have an adequate cost system.

The Bureau of Public Roads has abandoned the practice of keeping costs of all of its contract jobs but is instead keeping costs of all day labor work and of such contracts where it is thought the data will be advantageous to the Bureau. It will prove advantageous to a state highway department to collect cost data on a number of representative contracts each year as a general check on the cost of its designs and also to determine the margin of profit contractors are getting.

The increasing use of cost keeping by contractors is even more pronounced than in the case of the state and county organizations. This is due principally to the unsettled conditions during the past three years which have made estimating more difficult and rendered as practically useless many cost data and hypothetical rules used a few years ago. New construction methods, and especially those processes requiring a more extensive use of equipment have also increased the need of cost keeping. Possibly the increasing number of engineers in the contracting field has had some effect in turning contractors to cost keeping. It will be found that highway contractors are now working individually and through their organizations for more systematic and business-like methods in estimating work and in the keeping of construction costs. While no uniform method for keeping highway costs has as yet been suggested by contractors' organizations, practically all contractors are now keeping costs on their work. Some of the systems are almost of the check book class in simplicity but they vary from this to a codified system of accounts divided and subdivided to collect cost of labor, materials, equipment and supervision on various operations. It appears that the present tendency is for highway contractors to develop cost keeping systems comparable with those in use by the building industry.

Primary Purpose of Cost Keeping

The primary purpose of cost keeping is to ascertain the actual cost of production. Not what the cost should be, but what it is. For a contractor's use the cost system should furnish reliable data on current costs. In this way a periodic check on the cost of the work, which is an indication of the efficiency of the organization, is available as a managerial aid to the contractor or his superintendent. This function of a cost system is of special value on highway work where there are usually a number of operations under way simultaneously on different parts of the job and in consequence all of the workmen are not continuously under the observation of the superintendent. Next in importance to the contractor is the value of cost data as a guide for estimating future work. The increasing complexity of highway construction is making cost keeping of more importance. The large sums of money now involved in road contracts mean more items of work, new processes, and additional operations over former requirements. To estimate the cost involved without comparable cost data is becoming too costly a hazard. It is not enough to know that there was a net profit on the job, but in order to use the data for estimating purposes it must be known by items and operations, the actual cost of production.

In the construction industry it is not practicable to determine unit costs with the precision and refinement that obtains in the manufacturing industry. This is due to the variable nature of the construction product and the frequent change of conditions. Also, since conditions are not identical on any two jobs cost data from one is only an approximate comparison for another. For these reasons cost data must be used as a guide or measure in forecasting

(*) Paper read at American Water Works Convention, Cleveland.

1. Valuable cost data are secured which may be used for estimating purposes. Cost data on new or unusual methods of construction and on the use of various plant units are of particular value as similar conditions are likely to be encountered in the future and a basis for cost estimates is available.

Basis for Cost System

It is believed that the proper basis for a cost system is the four principal elements of cost allocated to the units of production.

- (a) Labor costs.
- (b) Material costs.
- (c) Equipment costs.
- (d) Administration costs or general expenses.

The products of highway construction to which these cost elements are assignable are road parts. Fundamentally these parts are:

- (a) The right of way.
- (b) The roadside, shoulders, and grade.
- (c) The travelled way or roadway proper.
- (d) Drainage channels or ditches and drains.
- (e) Drainage structures or bridges and culverts.
- (f) Supplementary structures or miscellaneous road parts, such as guard rails, retaining walls, guide posts, etc.

Thus, there are six major products on each of which there may be four elements of expense or cost; consequently, we have 24 cost divisions. Since general expense is not ordinarily ascertained directly on production but is prorated to the various operations, the actual cost divisions with which the cost keeper is directly concerned are reduced to 18. It is believed that this is the minimum number of cost divisions which will provide a satisfactory highway cost keeping system. These cost divisions are susceptible of much further analysis by breaking them up into various operations. For example, a square yard of concrete roadway is one of the unit products. The cost divisions for this are three, i.e., labor, materials, and equipment. To these three may be added the prorated general expense. For further analysis, this square yard of roadway may be subdivided into sub-grade finishing, placing of forms, hauling materials, mixing concrete, placing concrete, curing concrete, etc. This illustrates how the system may be expanded to meet the requirements of any desired analysis.

In placing the cost items against the appropriate construction items the greatest difficulty appears to be in correcting with "equipment costs" and "administration costs." It is the experience of the Bureau of Public Roads on its own work that these items are given less attention in the preparation of estimates and in the segregation of cost to construction items than the more nearly definite items of "labor" and "materials."

The handling of equipment costs has been greatly simplified by the use of a rental factor computed to cover fixed charges, depreciation, overhauling, lost time, storage, and supervision. In the case of its own plant the Bureau has prepared rental schedules for all units of equipment having a useful life or more than one working season and costing more than \$25. Small tools and those which are usually worn out on one job are handled the same as materials. This plan has been in operation three years and except for a change from a monthly to a daily basis it is practically the same as originally developed. It has proven satisfactory on both day labor and contract work of the Bureau. A rental factor of this kind is necessary where current costs are determined for purposes of management. If greater accuracy is desirable for fiscal purposes and annual appraisal of the equipment may be made and the depreciation, repair, storage and other charges prorated to the projects which have used the equipment.

As general expense is not usually assignable directly to units of construction and many of the expenditures do not come to the attention of the cost keeper on the job there is a tendency to overlook this element until the project nears completion, at which time the cost is prorated to the work completed. The result is a sudden jump in unit costs. Even with this apparent defect this may prove the best method

to adopt as it greatly simplifies the handling of general expense items. Where limited funds require careful attention to gross expenditure on a project this method is not recommended. Occasionally it is found that the general expense is quite high in starting a job and if this is prorated to the small accomplishment during the first few weeks of the work there are shown abnormally high unit costs which are not a true indication of conditions. Two suggestions are offered for the handling of general expense. First, it will be found advantageous to divide general expense into two parts, one of which includes those costs which are assignable directly to the project and the other the general administration costs of the organization which must be prorated to all its various projects. This latter part need not be considered in current cost reports as it does not in any way affect the efficiency of the construction organization on the project. This part of the general expense may be apportioned to the project upon its completion. The second suggestion is that the amount of general expense (project) taken up and prorated on current reports be a percentage of the total probable general expense, which percentage to be not greater than the percentage of the project completed. For example, if the project is only 10 per cent complete, prorate to completed work not more than 10 per cent of the total probable general expense. On projects where the cost of "moving in," "camp installation," "organizing," and "disorganizing" is of a considerable amount the unit construction costs are liable to be materially affected if this entire cost is distributed before the work is well under way.

Fundamental Principles of Cost System

A cost keeping system to be successful must be based on certain fundamental principles. First of all it must be designed to furnish the particular information sought. This feature can not be too strongly emphasized as not infrequently much more time is spent in perfecting quasi-scientific forms, codes, and procedure than is given to working out a cost system for getting at the cost of doing work. The system devised must be reliable and accurate to a practical extent. In-so-far as field procedure is concerned simplicity is a very important consideration and it should be such that the required data can be successfully compiled by foremen and timekeepers. The effectiveness of the system will depend to a great extent on the celerity with which the unit costs may be ascertained. Unless the cost of doing the work can be determined easily and promptly its value as an aid to efficient management is lost. Some consideration should be given to making the cost system adaptable to the general work of the organization and not design it entirely for an individual job or set of conditions. It requires time and considerable patience to get a system in working order and frequent changes in forms and instructions should be avoided as they are generally disconcerting to the men in charge of construction work. It must be understood that cost keeping lies in the general book-keeping scheme of the organization and is not to be operated independent of the regular accounting. While the cost-keeper and bookkeeper make different use of the information, the basic data used should be the same. One of the reasons cost keeping has not received more encouragement in the past from engineers and contractors has been the question of its cost. A system laid out along the lines indicated and designed to give the information needed for the proper supervision and administration of the work of an organization need not be expensive considering the volume of business it handles. It is when a system is developed beyond the requirements of the organization that cost becomes an important consideration.

A review of the present status of cost keeping on highway work indicates that it is still very much in a formative stage. There are some excellent systems in operation in many of the state highway departments and among the larger contracting organizations, but on the larger part of the extensive highway program cost keeping as practiced leaves much to be desired. A great step forward would be accomplished by a general classification of cost keeping terms. Many of these as are used are subject to several in-

interpretations. Engineers and accountants could materially improve the situation by reaching a common understanding in this regard.

As an indication of the present interest in highway cost keeping it is interesting to note that since the publication by the Bureau of Public Roads of its Cost Keeping Bulletin more than five thousand copies have been distributed.

TOWN PLANNING INSTITUTE MEET

PRELIMINARY arrangements have been made for the Third Annual Meeting of the Town Planning Institute of Canada which takes place at the Chateau Laurier Ottawa, on Friday and Saturday, May 12 and 13. The tentative program is as follows:

Friday, May 12

2:30 p.m.—Council meeting.

5:00 p.m.—Registration and annual business meeting.

Reports.

Constitution.

By-laws.

7:00 p.m.—Annual dinner.

President's Address: In the absence of the President, Dr. E. Deville, the address will be delivered by the first vice-president, Noulan Cauchon.

Brief Addresses by: Mayor Plant of Ottawa; Hon. Rodolphe Lemieux, Speaker of the House of Commons; Senator Fowler; Thomas Adams, past president of the Institute.

Announcement of election of new president and officers.

J. P. Hynes, Chairman of the Ontario Town Planning and Housing Association—"Where the Responsibility for Town Planning Belongs."

Saturday, May 13

10: a.m.—Papers.

(1) "The Suburban Problem," W. E. Hobbs, director of town planning, Province of Manitoba.

Discussion.

(2) "Town Planning Point of View," T. D. Le May, City Surveyor of Toronto.

Discussion.

(3) "Zoning," Thomas Adams.

Discussion.

Lunch: Round Table.

3:00 p.m.—Open.

CANADIAN SECTION A.W.W.A. BRANTFORD MEETING

SEVERAL interesting papers are on the program which has been arranged for the annual meeting of the Canadian Section of the American Water Works Association which meets at the Kirby House, Brantford, Ont., on Friday and Saturday, May 12-13. The program is as follows:

Friday, May 12

2:00 p.m.—General Business.

Election of Officers for 1922-3.

3:30 p.m.—"Government Control of Sewage," by F. A. Dallyn, sanitary engineer, Department of Public Health, Ontario.

4:30 p.m.—"Filter Plant Construction," by R. L. Dobbin, Waterworks Superintendent, Peterboro, Ont.

6:30 p.m.—Banquet at Brantford Golf and Country Club.

Saturday, May 13

9:00 a.m.—"Treatment of Impure Hard Water," by William Gore, of Gore, Nasmith & Storrie, Toronto.

10:00 a.m.—"Manufacture of de Laval Cast Iron Pipe," by Professor Gillespie, Toronto University.

11:30 a.m.—"Standardization of Hydrant Threads," by Norman McL. Wilson, chief engineer, Brantford Water Works.

In connection with the convention, manufacturers of water works equipment and supplies are putting on an exhibition in a room adjoining the convention hall. Those

manufacturers who have not yet sent in registration for space (which space is to be provided free of charge) are advised get into touch with Norman McL. Wilson, chief engineer, Brantford Water Works, or Mr. Jordan, of Dominion Steel Products, Ltd., Brantford, who are in charge of this feature of the convention.

DIESEL ENGINE EQUIPPED SHOVEL

AFTER a long period of thorough experimentation, the Bucyrus Company of South Milwaukee, Wis., has developed a Diesel engine equipped shovel. The importance of this announcement lies principally in one outstanding fact, the fuel cost. This shovel, known as the Bucyrus 30-B oil shovel, will use as fuel, any cheap low-grade oil of high heat value which will flow freely.

The saving in the cost of fuel thus obtained is considerable. This machine has been under severe test for several months, under strenuous winter conditions, both as a shovel and as a dragline. These tests have shown that with fuel oil at 6c. per gallon this machine will consume 1 1/4 to 2 1/4 gallons of fuel oil per hour. This means a fuel cost of 10 1/2c. to 13 1/2c. per hour, or, roughly, between \$1 and \$1.25 per day of average operation.

The economies thus made possible to a shovel or dragline operator may be realized by comparison with a steam shovel of the same size. All practical men know that the fuel cost of any shovel differs widely in different sections of the country. Conservatively stated, however, such a shovel will burn about 1 1/2 tons of coal in 10 hours. With coal at \$6 per ton delivered, this means a daily fuel cost of not less than \$9. A saving of \$8 per day on fuel alone is thus possible. To this figure may be added the saving made possible in not having to pay for hauling water and coal.

The engine is of the full Diesel type, known as a mechanical injection engine, developing 55 h.p. at the conservative speed of 360 r.p.m. The cylinders are 8 in. by 10 1/2 in. It is a heavy duty, slow speed engine of particularly rugged and heavy construction, adapted well to the severe service it must undergo in excavation work.

The Diesel type engine differs from the gasoline engine principally in that it is a constant pressure engine, the fuel being burned directly in the cylinders without the aid of a carburetor, spark plug or outside heating appliances. In the gasoline engine the mixture is taken into the cylinders, compressed, and then ignited by some auxiliary mechanism. The pressure then rises in the nature of an explosion. In the Diesel type engine the fuel is injected into the cylinders at a constant pressure in an atomized state. It is fired by the heat developed by the compression of air in the cylinders on the previous stroke. Thus the sudden pressure due to the explosions in the gasoline engine is eliminated, making the engine steadier running and easier to maintain. The 30-B oil machine, equipped with a Diesel engine, may be furnished either as a shovel, a dragline, a clamshell or a locomotive crane. The Bucyrus shovel is handled by Musens Limited, Montreal.

EXPENDITURE ON MANITOBA ROADS

FROM a report of the Manitoba Good Roads Board, recently issued, it is shown that expenditures to the amount of \$906,244 were made by the municipalities and the Province of Manitoba on roads which are entitled to Federal aid under the Canada Highways Act from the inception of the act in July, 1919, to September 30, 1921. Nearly all of this sum has been approved by the Federal auditor for payment to the Province of the Dominion's share of 40 per cent.

The report states that Manitoba's share of the \$20,000,000 appropriated by the Parliament of Canada to aid Provinces under the act, is \$1,602,265, but according to the terms of the act no portion of this money can be received by the Province on expenditures on roads which have not been placed under agreement for improvement by the Minister of Railways and Canals, Canada, and the Minister of Public Works of the Province.

BRADFORD, ENG., WATER SUPPLY

Supply From Impounding Reservoirs — Economy of Soft Water For Industrial Purposes — Comparison of British and American Consumption.

IN dealing with the history of the Bradford (England) water supply, Lewis Mitchell, water works engineer, gives some very interesting data. The water supply of Bradford has been municipally owned since 1855. The city originally obtained its supply from the Aire Valley, going further afield as the necessity arose. The corporation tapped sources in the Wharfe Valley, and finally the valley of the Nidd. The Nidd River rises in Great Whernside, one of the highest peaks of the Pennines, and the supply is drawn from a point of high altitude from which the water can be delivered by gravitation to a high level in Bradford.

The area of the corporation's watersheds is 26,080 acres. Six reservoirs, viz., Angram, Upper and Lower Barden, Chelker, Thornton Moor and Stubden, are used solely for impounding water for city supply; and seven reservoirs, viz., Hewenden, Grimwith, Silsden, Doe Park, Leeming, Leeshaw and Gouthwaite have been provided to compensate the owners and occupiers of lands and mills and other parties interested in the sources from which the water has been diverted. With the exception of the water drawn from Stubden Reservoir and Manywells Springs, the whole of that supplied by the corporation is filtered before it is delivered to the city. The Barden supply is filtered at Gilstead, the Nidd supply at Chellow Heights, and the Thornton Moor Supply at filters which are contiguous to that source.

All sources of supply are initially dependent upon the rainfall. There are no fewer than forty gauges on the Bradford Corporation catchment areas. In Britain the rainfall varies from about 20 in. in the eastern counties to 130 in. per annum in the hills of Cumberland, Wales and Scotland. On the corporation's watersheds it ranges from an average of 32 in. to 54.4 in. as compared with the average of 39.5 in. for the British Isles.

The water thus obtained is comparatively soft, having only 2.5 degrees of hardness as compared with 1 degree in Glasgow, 3 degrees in Manchester, 7 degrees in Edinburgh, 15 to 20 degrees in London, and 30 degrees in Sunderland. This is an important characteristic, because when trades such as wool-washing, dyeing, bleaching, tanning and calico printing are extensively conducted, a soft water is a necessity. For trade, manufacturing and boiler purposes, it is unrivalled. When it is remembered that iron conducts heat eighteen times better than calcium carbonate, and fifteen times as readily as calcium sulphate, and that 1/6 in. of scale on a boiler necessitates the use of 16% more fuel ¼ in. 50%, and ½ in. 150% additional coal, the value of a soft water will be appreciated. The only manufacturers who require a water with permanent hardness are the brewers, who, for brewing light colored beers, actually add gypsum when the water is deficient in that ingredient. For domestic use a soft water has also many advantages, there being a considerable saving effected in the cost of soap, soda and tea required.

In a surface water supply which is close to inhabited centres, it is difficult to prevent pollution at the source. Consequently many large towns and cities have gone considerable distances for supply rather than use one of doubtful purity. Manchester went to Thirlmere and Haweswater (a distance of 100 miles), Glasgow to Loch Katrine, Liverpool to Vyrnwy (66 miles) and Birmingham to the Elan Valley (80 miles).

There is little question as to the desirability of filtering a surface water supply before delivering to consumers. Manchester and Glasgow are the only large water authorities in Britain that have not made this provision. Prolonged storage has undoubtedly a beneficial effect, but in relatively small reservoirs the clarification effected is far from adequate. In Bradford the total extent of the filtering area is in excess of 8 acres. The filters in use are of the

slow-sand type, and consist of a water-tight basin containing a layer of fine sand from 2 to 3 ft. in thickness, supported by a layer of gravel or broken stone in graded sizes from 6 to 12 in. in depth, below which are the underdrains.

The action of the filter is entirely biological, depending on the thin, slimy and gelatinous film formed on the surface. The lowest chemical and bacteriological efficiency is recorded immediately after cleaning, and if the rate of filtration is regular and continuous, the degree of purification effected gradually increases. The rate of filtration is two million imperial gallons per acre per day.

From the filters the water is discharged into service reservoirs, of which at present only three are covered. The covering of these reservoirs was found necessary to prevent the growths of algae and infusoria, and their subsequent entrance into the city supply. From the service reservoirs the water flows by gravity to the distribution system.

Water supplied for domestic purposes is charged for by a rate levied upon the gross annual value or rack rent of the premises so supplied. The water used for other purposes, such as trade or manufacturing, is metered, a charge being made for each thousand gallons so delivered.

In Bradford with a population of 400,000, the consumption is now 18 million gallons per day, with an average daily per capita consumption of 46 gallons. Of this latter amount one-half is used for trade and manufacturing purposes. In London the daily consumption is 34 gallons, in Manchester 36, and in Glasgow 60. The average for the principal towns in Britain is 35 gallons, ranging from 18 in Norwich to 80 in Paisley. New York requires 100 gals. and Washington 150 the average being nearly three times as high as in Britain.

CHANGE OF DATE FOR GOOD ROADS MEET

IN order to make it concurrent with the provincial meeting of the Engineering Institute of Canada, the date of the ninth annual meeting of the Canadian Good Roads Association has been advanced one day. The good roads convention will now be held at the Empress Hotel, Victoria, B.C., on Monday, Tuesday, Wednesday and Thursday, June 12, 13, 14 and 15, while the meeting of the Engineers will be held at the Vancouver Hotel, Vancouver on June 16 and 17. The members of the Engineering Institute will attend the Good Roads Convention in Victoria and the delegates to the latter will at the conclusion of their labors return to Vancouver and assist at the Engineering meeting, it being realized that the two organizations have much in common, and can be of much assistance to each other.

The special summer tourist fares will be in effect so that the railway fares will be much less than the ordinary rates. The return fare from Halifax will be \$170.75, Charlottetown, P.E.I., \$169.55, St. John N.B., \$163.25, Quebec City, \$142.45, Montreal, \$132.30, Ottawa, \$126.55, Toronto, \$109.55, with pro rata rates through the prairie provinces to the coast. These fares will be on either the Canadian National Railway or the Canadian Pacific Railway, while those delegates wishing to return via San Francisco can do so at an approximately additional cost of \$20, or via Prince Rupert for an additional \$13.

The Canadian Good Roads Association officials have been assured that every province in the Dominion will send official delegates to the convention, while many of the municipalities that have participated in past conventions, and realized the great value of the papers and discussions that take place at them on highway problems, are sending their officials to Victoria, feeling that the expense incurred will be more than offset by the savings they can later effect in road construction and maintenance through the knowledge gained at the convention.

The President of the Association, the Hon. S. J. Latta, Minister of Education in the Saskatchewan Government, will preside at most of the sessions, and so important are the subjects chosen for discussion that the Executive have for the first time extended the convention, from three to four days.

2000 feet of cast iron or steel pipe near the lake and the balance of the pipe line of woodstave pipe. An intermediate reservoir was to be provided at a point about two miles south of the City. This was to be a reinforced concrete covered reservoir with a capacity of 300,000 gallons. Its purpose was to equalize the load on the pumps and to provide for keeping the wood pipe line full of water at such times as the present plant would supply all the water necessary.

The general idea of the scheme was based on the fact that the existing water supply of the City could be depended on for a minimum of 1,500,000 gallons per day for five months of the year, during the other seven months the supply being ample for present needs. Lake Erie

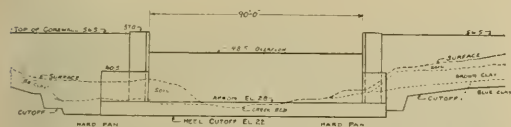


FIG. 3—KETTLE CREEK DAM, DIAGRAM, SHOWING PROFILE OF CREEK BED AND CORE WALL EXTENDING INTO BANKS

scheme therefore would act as an auxiliary supply the raw water being pumped untreated and would be filtered in the present filtration plant.

The capital cost of the scheme including pumping plant, intake, intermediate reservoir, pipe line and right of way was estimated at \$450,000 with annual charges for interest, sinking fund, and operation and maintenance of \$59,000.

As the present annual revenue from all sources is only \$60,000 per annum, it is seen that water rates would have to be at least doubled to finance the Lake Erie scheme. Consideration was therefore given to the development of the Kettle Creek watershed.

Precipitation and Run Off Investigations.

As in common in most smaller cities the officials had never seen the necessity of keeping records that would be of value in investigating a problem of this kind. The only really authentic information available being the pumping records during the dry summer of 1919. It was known that during this season the storage was being slowly reduced. Considering the dependable flow from the wells at 1,000,000 gallons per day it was estimated that the minimum flow of the creek during the summer was approximately about 500,000 gallons per day or less than one cu. ft. per second.

The paucity of information with which to work compelled Mr. Lea to make a most exhaustive inquiry into the subject of rainfall and run off in Western Ontario. Records were kindly furnished by the City of London, Hydro-Electric Power Commission, Water Power Branch of the Dominion Government, and the various Meteorological stations in Western Ontario.

Records of the monthly precipitation at Paris, London, Guelph, Georgetown and Port Stanley from 1893 were compiled and studied carefully in conjunction with the run off records for the period 1914-18 inclusive of the Speed River at Hespeler, the Thames River at Ealing, the Grand River at Belwood and the Credit River at Cataract Junction.

It was found that for the four years the total run off varied on the different watersheds from 12.23 inches to 14.79 inches, the average of the four watersheds for the five years being 13.23 inches.

The lowest run off recorded for any one year was for the Grand River at Belwood it being 6.15 in. for the year, 1.41 in. for nine months and 0.42 for six months. Assuming that the monthly records of run off for this low year would apply to the Kettle Creek watershed, the average flow in gallons per day of Kettle Creek would have been

June 780,000, July 260,000, August 520,000, September 520,000 gallons per day.

Having regard for the fact that the run off of the Grand River as compared with the next lowest run off recorded in Western Ontario is less than one third for the six months period, less than one half for the nine months period and about 80% for the year, and also having regard for the fact that the lowest recorded monthly run off of the Grand River little more than half of the lowest known runoff for Kettle Creek in proportion to the watershed area Mr. Lea assumed that the run off for the Kettle Creek watershed could be safely assumed to be at least as great as that of the Grand River at Belwood.

Total Daily Supply.

A detailed analysis on this basis gave 25,000,000 gallons per day as a yearly average, with a safe average of 2,000,000 gallons per day over a nine months period. To supply an average annual demand of 4,000,000 gallons per day would require about 4,500,000 gallons per day during the summer months. Allowing for evaporation and other losses, it was proposed, therefore, to provide a storage of 350,000,000 gallons. This, together with the 1,500,000 gallons per day already available, would give a minimum daily supply of 4,000,000 imperial gallons. The construction of a dam at some point north of the city, therefore, became necessary.

Jas. A. Bell, who has had long experience with the geology of this district, was called in at Mr. Lea's suggestion. Mr. Bell located a suitable foundation at a point about one mile north-east from the pumping station. Here an underlying strata of very hard blue clay, known locally as hardpan, was encountered a few feet below the creek bed. Artesian wells in the vicinity shewed this strata to be about 70 ft. deep.

Two Steel Bridges Raised.

The selection of this location made necessary the raising about 10 ft. of a 90 ft. 80 ton steel highway bridge located about 120 ft. upstream. It was first thought that the approaches to the bridge might be used as an earth section, and that the spillway might be constructed immediately under the bridge. Investigation shewed, however, that the concrete section of the work would thus have been made unduly expensive.

One mile upstream a second steel bridge was dismantled. This bridge served only one farm and the acquisition of that farm by the city, offered the easiest solution here. A second highway bridge about two miles



FIG. 4—KETTLE CREEK DAM—POURING NORTH CORE WALL

upstream, could not be so easily disposed of. The raising of this bridge a distance of seven feet involved the reconstruction of the abutments and the making of about 8500 cu. yds. of embankment.

The width of the basin averages about one-quarter mile from top to top of hill, the top land being about 70 ft. above the creek. It was necessary for the city to purchase the total width, resulting in the acquisition of

about 450 acres of land requiring about 1400 rods of fencing to enclose. The actual flooded area is about 160 acres, most of which required considerable clearing.

Figure 3 shows a profile of the creek bed and the materials encountered at the site of the dam, all being exceptionally suitable for the foundation of the structure.

Details of Dam.

To take care of the greatest possible flood flows, a spillway section 90 ft. wide and 8.5 ft. high, was decided upon, with the crest of the spillway at elevation 48.50. This was calculated to provide a storage capacity of 400,000,000 gallons and had the effect of raising the water 17½ ft. at this point and created a reservoir extending 3½ miles upstream from the dam.

The dam consists of an earth embankment with a 12 in. concrete core wall on either end of the spillway section. This is of the ordinary type of gravity section and is designed to give a maximum toe pressure of 2½ tons per sq. ft., with piers and stoplogs, these latter being required when additional storage has to be provided. The ends of the embankment, both up and down stream, are supported by reinforced concrete wing walls. These are shown in detail on Figure 1. The water course is paved immediately down stream from the spillway, the paving or apron terminating in a down stream cutoff.

Figure 3 shows the core wall cut-off extending into the banks, at the same elevation as the cutoff across the bed of the spillway, and then sloping up at a depth of 2 ft. below the hardpan or blue clay. The top of the earth section is at elevation 57, providing a 6 in. covering over the core wall, and is 12 ft. wide on top, with 2 : 1 slopes and paved on the up stream side adjacent to the south wing wall.

No sluiceway section is provided, control of the water being accomplished by the operation of flanged sluice gates with non-rising stems, located in the 4 ft. x 8 ft. gate chambers in the abutments. In the south chamber are one 16 in. and three 12-in. valves as inlets at elevations 31.5, 34, 40 and 46 respectively, and one 16 in. outlet valve at 29.5. In the north chamber is one 24 in. valve controlling the inlet at 31.4, while the 24 in. outlet at 29.7 has no valve.

Cost of Construction.

The contract was let on a unit price basis, to the Webster Construction Co., of London, Ont., the lowest

materials were washed away. The loss at the pumping station a mile below, was very heavy, as the creek broke through its banks and rushed 3 ft. deep over the pump house floor, only subsiding after about six hours.

The coffer dams were rebuilt and the creek flow taken care of by a diversion dug along the north bank, as shown on Fig. 1. This width represented one cut of the Keystone excavator with dipper attachment, and the flow of the water soon doubled the width.

Excavating in the base of dam and wing wall footings was carried out with the Keystone excavator. The material was exceedingly hard, and from July 28, to Aug. 22, was required for this work, the material being hauled into



FIG. 6—KETTLE CREEK DAM ON JAN. 19-1922

the embankment of the approaches to the bridge, just above the dam.

Progress of Concrete Work.

1 : 2 : 4 concrete with 1½ in. stone was used in wing walls, footings, apron, in the faces and top 6 ft. of spillway, and in the core walls, while 1 : 3 : 6 concrete with 2½ in. stone was used in the cutoffs, and interior of the spillway, the base to elevation 28, and the core wall footings. An 11 cu. ft. steam-driven batch mixer turned out 10 cu. yds. of concrete per hour under good conditions.

The first concrete in the dam was poured in the south wing wall footings on Aug. 23, and by Sept. 2 all the wing wall footings and base of dam were completed. The south wing walls were poured to elevation 48.5, the south-west wing and gate chamber walls being poured monolithic with a 5 ft. section of the spillway. This method was also employed on the north side. The central part of the spillway was poured in three sections, each about 27 ft. long, each section being poured in three lifts and completed to the crest before another section was started.

6 in. x 12 in. keyways were left and a crimped copper strip was placed 12 in. from the face, in all vertical joints. By September 30, the spillway was completed and on Oct. 14, the wing walls and gate chamber were poured. The valves were then placed in the gate chambers, the diversion closed off and the core walls proceeded with. The first concrete in the core walls was poured on the north side on Oct. 17, the last section being completed in the south core wall on Dec. 2. As the walls went up the embankment was built from material excavated from borrow pits.

An unfortunate feature of the work was that the year decided upon for construction brought not only the greatest flood on the Creek in the memory of any one now living, but floods in greater numbers than for several years. Five floods washed over the coffer dam in September, rising rapidly during the night.

The total excavation involved the moving of 11,000 cubic yards of earth work, while 2300 cubic yards of concrete and 23 tons of steel were required.

The total cost of the Dam, including engineering, was approximately \$70,000. The raising of the two bridges involved an expenditure of \$11,000 each.

The design of the dam was made by W. S. Lea and Messrs. James A. Bell & Son, the latter firm supervising



FIG. 7—KETTLE CREEK DAM PART OF FIRST SECTION SPILLWAY POURED

bidder in a field of seventeen. Approximate quantities for the eight main items were supplied the tenderers, and on these the bids ranged from \$44,738 to \$105,830. The contractor began work on July 4, 1921, and was practically complete by the first week of January, 1922. Earth coffer dams were started across the creek and these were about 30% completed when the greatest flood in the history of Kettle Creek took place, the creek rising 10 ft. in twelve hours, reaching a flow of 7000 sec. ft. on the morning of July 10. The coffer dams and a considerable quantity of

the construction. The raising of the bridge immediately upstream from the dam was also carried out by James A. Bell & Son, while the second bridge was raised and abutments re-constructed from designs prepared by W. C. Miller, city engineer of St. Thomas. George H. Chalmers was resident engineer on all three projects. The Water Commission consists of Albert Roberts, Chairman, George Geddes and the Mayor of St. Thomas.

REGULATION AND TESTING OF LARGE MODERN HYDRAULIC MACHINERY

AT THE symposium of hydraulics recently held at the University of Toronto, two lectures were given by Norman R. Gibson, hydraulic engineer of the Niagara Falls Power Co. His first lecture dealt with the regulating and testing of hydro-electric machinery, and his subject was presented in a very lucid and entertaining manner. He pointed out how regulation of the power-house machinery is a very vital requirement of a company delivering power, as both variation in voltage and frequency may be the cause of considerable loss to the customers. This is especially true in the case of paper manufacturers.

When the governor of a turbine adjusts the speed for any given load change, it performs the function of acceleration or retardation of the water column in the penstock; in this it is assisted by the fly-wheel effect of the revolving parts of the generator and turbine.

In reference to the testing of installed apparatus, Mr. Gibson pointed out how this is not so much a necessity for checking up the manufacturers' guarantees as it is for indicating to the owner of the plant how the machinery is standing up under service; testing thus becoming a periodic requirement of any operating plant. Results of periodic tests indicate the advisability of making repairs, renewing runners, and in every way keeping the plant up to its maximum state of efficiency.

The difficulty of making exact measurements of any physical quantity was discussed by Mr. Gibson, and where the quantity to be measured is in three dimensions, such as the quantity of water, the problem is correspondingly more difficult. When the time element is also introduced, such as is required when the rate of flow has to be measured, further complications are encountered. The accepted method of measuring flow, such as by venturi meters, pitot tube, weir and chemical gauging, are all capable of giving satisfactory results, said Mr. Gibson, but when it came to determining the flow in the large modern plants, these methods are often both expensive and difficult. The necessity for obtaining accurate means for readily determining the efficiencies of large turbines, led to the investigation which resulted in Mr. Gibson's invention for measuring the flow of water in penstocks.

The arrangement of the measuring apparatus and its connection to the penstock were described and shown by slides. The method consists in obtaining an accurate photographic record of the change of pressure in a penstock when the flow is shut off, the rise of pressure for a period of time being an exact measure of the velocity of water flowing up to the time it was shut off. A photographic record obtained by the apparatus indicates the pressure-time area, and at the same time the scale of time is accurately shown by means of a record of a swinging pendulum obtained simultaneously with the photograph of the pressure rise.

UTILITIES COMMISSION WATER WORKS PROJECT.

FROM a report upon the water works project submitted to the Essex Border Utilities Commission by J. Clark Keith, it is understood that filtered water could be supplied to the property owners of Windsor, Ont. at 2½¢. per 1000 gallons in excess of the rate in effect at present. The report will be considered at a special meeting of the Commission at which representatives of the Walkerville Water Co. and the Windsor Water Commission will be present.

It is proposed to have the border municipalities submit three questions to the ratepayers if it is decided to go through with the scheme. The first so far as Windsor is concerned, would be, in effect: Do you want filtered water; if so, do you want Windsor to instal a filter of its own; or, do you want the city to enter the union scheme advocated by the commission?

The report deals solely with the cost of supplying filtered water at the pumping stations of the Walkerville Water Co. and the City of Windsor.

In making this report there has been no departure from any of the principles adopted by the board, nor any changes in the quantities involved, except in minor instances. The board included in its figures the cost of a high lift pumping station at Strabane avenue for purposes of comparison with that of a complete filter plant and high and low lift station at the Windsor waterworks. Until the expiry of the franchise of the Walkerville Water Co. in 1952, or unless a fusion of all the border municipalities shall have become an accomplished fact before that date there will be no change in the operation of the existing waterworks system prior to that time. For that reason, a low lift station only, would be constructed at Strabane avenue at the present time, and either oil or gas would be utilized as a standby, instead of steam.

A revision of the estimates submitted by the engineers' board on the cost of an intake, low lift pumping station, filtration plant, and pipe line for conveying filtered water to the suction wells or piping systems of the Walkerville Water Co. or Windsor Waterworks has been made in detail in accordance with present day prices. Before adopting any of the unit prices used in this report, conferences were held with officials of the Walkerville Water Co., and they concurred in the basic figures used.

An effort was made to effect a similar arrangement with the Windsor Water Commissioners, but they were not in a position at the present time to discuss any elements of cost.

NEW PUMPS FOR CITY OF MONTREAL

THREE single-stage centrifugal pumps, each having a capacity of 30,000,000 Imperial gallons per 24 hours, are being built for the Montreal Water Board at the shops of the Dominion Engineering Works, Ltd., Montreal. These pumps will be installed in the Atwater St. Pumping Station and will operate against 250-ft. static



SHOP VIEW SHOWING PATTERN AND CORE BOX FOR UPPER AND LOWER CASING OF 30,000,000 GAL. SINGLE-STAGE CENTRIFUGAL PUMP FOR MONTREAL WATER BOARD

head. They will be driven at 625 r.p.m. Each pump will be direct connected to a 2,000-h.p. motor. Among other equipment which the Dominion Engineering Works are supplying to the Montreal Water Board are 4,000,000 lb. of special 36-in. cast iron flanged pipe and fittings and 42-in. pipe and fittings, and six 42-in. gate valves

ELECTRICAL OPERATION OF GATE VALVES*

Valves Closed Quickly in Emergency — Prevents Flooding and Consequent Damage to Property — Description of Dean System of Valve Control.

By Peter Payne Dean

FIVE years ago the electrically operated valve was almost a thing of the past, its development having entirely stopped in favor of cylinder operation, but since that time it has again come to life and is now making rapid strides, threatening seriously to eliminate cylinder operation for almost every use, and entirely, where distant control is required.

A large gate-valve, after having been installed for some years and without much care, becomes exceedingly hard to operate and sometimes requires the efforts of six or eight men to close. Being difficult, and requiring so much physical effort it is consequently avoided and gradually gets in worse condition, so that when it is required in an emergency, it usually fails to function. Valves of this type are always a source of worry to the waterworks superintendent.

Shut-offs take considerable time and in the event of a break much damage may be done by an uninterrupted flow. To be able to close a pair of 36 or 48 in. gate valves, in say 10 or 12 minutes, with only one operating man, would at least save a bad wash-out and considerable property damage.

Standpipe valves, to operate from a remote point, are also of importance, as by certain operation high pressure may be pumped directly into the mains. Pump discharge valves are very frequently electrically operated, allowing different pumps to be put into service very quickly.

With electrically operated pumps of the centrifugal type, the failure of the check to close, when the pump is shut down, would probably cause considerable damage, and by applying electrical operation to the discharge valve next to the check the pump and motor may be afforded additional protection.

Danger of Flooding.

Breaking of mains is undoubtedly the most important consideration for electrically operated valves and by choosing a combination system of electric control for the most important valve and a portable automobile type of control for outlying districts and smaller valves, a shut-off may be effectively made.

We have certain extremely congested business centers in our large cities that would suffer untold loss and inconvenience if badly flooded. Public buildings, such as art museums and libraries, housing some of the most valuable works of art in the world, would be seriously threatened if large volumes of water were to get at their foundations. Underground railways usually suffer most from this kind of flood, as they are below the street level and while the third rail is submerged, the system is out of commission.

These and hundreds of other reasons for flood protection should receive serious consideration from municipal authorities. Strange to say, however, they admit the seriousness of the situation and yet do not seem to make much of an effort towards finding a remedy. One reason, perhaps, is the lack of information on power operating devices for attachment to existing valves, and then again the valve manufacturers have never actively pushed any form of mechanically operated valve.

The superintendent is thus left to his own resources and knowing the conditions under which such valves are expected to operate, perhaps does not believe that there is anything available to do the work.

A few well-placed electrically operated control valves would afford, no doubt, ample protection to a congested district. But, of course, the number would have to be limited

on account of the expense. Since I have never yet found any water works man to argue against power operation of valves but on the contrary readily admit their value, I would like to explain here, why in my opinion, electrical operation is the only system that fulfills all the conditions.

Electric Motors Reliable.

Electricity is now available at practically every point and is the most reliable power known. The electric motor has so advanced in construction and design as to be adaptable to any and every possible use. It can be made water-tight and to work submerged, or in the open, exposed to snow and ice. The apparatus is ruggedly constructed and foolproof and can be placed at remote points.

Conducting cable is now made with a lead and steel covering, suitable for laying in an open trench or being submerged without additional protection. Indication of the position of the valve gate may also be shown at any distant point by the aid of a few wires.

Last, but by no means, least, an electrical unit may be attached to the valve without in any way disturbing it and without shutting off the supplies, which is the most important consideration.

Operation of large gate valves in street vaults usually presents the greatest difficulty, for these reasons:

The valve may be very old and exceedingly hard to operate.

It must be closed under a velocity in the line due to a break.

The control unit must be of such size as to pass through the ordinary man-hole.

The unit must be absolutely water- and damp-proof and stand partial submergence, caused by volumes of water passing through the man-hole covers.

It must be constructed to be left inoperative for long periods but always ready to operate in case of emergency.

It must not be affected by extreme cold, must be self-lubricating and must have a positive stop at both ends of the gate travel to prevent jamming.

Such operating conditions call for an entirely special device and the Dean Control was designed with entire regard for operating under such conditions.

Dean Valve Control.

The Dean System of Valve Control, which is the outcome of these observations, is built on somewhat radical lines with five particular features incorporated, namely:

1. A single unit system
2. Can be attached to existing valves with a minimum of effort and without shutting down the line
3. Is positive in operation and does not depend upon momentum or drift of moving parts to seat
4. Has ample unseating and seating torque
5. The whole unit is enclosed and waterproof.

The system consists of a single unit in which is incorporated the driving motor, reduction gears, and limit trip mechanism. The feet of the unit are provided with four, holding down bolt holes of standard dimensions for a given range of valves. Four standard units cover the complete line of valve sizes in use.

The motor is totally enclosed and waterproof and possesses an extremely high torque. It is connected to a system of combination worm and planetary gearing for the necessary reduction in speed. The motor speed is normally 1600 r.p.m. and the slow speed shaft 40 r.p.m., the gear reduction being 40 to 1.

The motor shaft is coupled to the worm shaft, both running on ball bearings, and the worm wheel is keyed on to a sleeve forming the sun pinion of a planetary gear. The planet pinions revolve on large studs forced into a flange on the slow speed driving shaft and these pinions mesh into the internal gear forming the outer member of the planetary.

The system is built for either alternating or direct current for voltages up to 220. pressures beyond this being unsafe.

*Paper read at American Water Works Convention, Cleveland.

LOCAL MINERAL AGGREGATE IN BITUMINOUS MACADAM ROADS*

Practically Any Clean Stone or Gravel Can be Used for Aggregate—Many Surface Failures Due to Poor Subgrades or Improper Mixing

By Major W. A. Welch

Chief Engineer, Palisades Interstate Park Commission.

PROPER use of local mineral aggregate in bituminous road construction means great economy in these days of high transportation and labor costs. It is possible to build good bituminous macadam road surfaces with practically any stone or coarse gravel found in the United States, provided this aggregate is free from loam, dust or silt when used.

The bituminous mixture is, at best, a wearing surface like the rails of a railroad, and it must be thoroughly and properly supported by the subgrade or it will fail. The subgrade is the real road, it must be properly placed, thoroughly drained, well settled and compacted and, on such a subgrade, a bituminous surface can be laid successfully with a mineral aggregate of comparatively low crushing strength, except on trunk roads. It is, of course, very necessary to thoroughly bond this aggregate and keep it free from moisture, dirt or dust, for these are, in my opinion, the greatest enemies of proper bonding.

Compares Highways With Railways

A railway engineer establishes the size and weight of his rails in accordance with the weight and speed of his traffic. On main trunk lines, these rails are made heavy enough to carry the heavy fast traffic, in spite of minor defects in the subgrade, but on the branch lines and feeders these rails are lighter for the sake of economy. Experience has taught these things and many others to the railway builders, and the highway engineer should profit by these years of experience and experiment, for our highways have become very like our railways. Your main trunk lines should have wearing surfaces which will carry any traffic and any speed, without failure, in spite of minor defects in the subgrade, but such surfaces are not necessary on minor roads and it is not economy to build them.

The safe crushing strength of trap rock or basalt averages approximately 350 tons per sq. ft.; granites, 350 tons per sq. ft.; limestones and marbles, 300 tons per sq. ft.; sandstones 215 tons per sq. ft.; good air-cooled slag, 300 tons per sq. ft. and ordinary chalk, 15 tons per sq. ft.

Practically all the stone in the United States comes within these limits and all of it, save the chalk and very soft sandstones, will make good bituminous macadam road surfaces. Specifications must vary with the types, the softer aggregates must be used in larger sizes, greater care exercised with them to keep out the dust and the rolling must be governed by the type of aggregate. The harder stone can be thoroughly compacted by heavy rollers and still be penetrated and thoroughly bonded by the asphalt or tar, but the softer stones, when used in penetration work, must not be rolled as hard or they will not allow the binder to properly fill the voids, and care must be taken to keep the aggregate even, as many quarries have seams or stratas of soft shaley stone, which, if put in with the better material, will cause trouble. More care must be taken with the top course or seal coat when the softer aggregates are used to insure a thorough coating on the actual wearing surface.

Causes Subgrade Failures

There is little accurate data obtainable on this subject, few experimental sections of such surfaces have been laid and watched. Of all the failures of bituminous macadam surfaces, which have come to my notice, none have been due in any way to the character of the mineral aggregate. By far, the greater number of these failures are due

to bad subgrade and the others to poor workmanship, dirt and dust in the aggregate or poor binding, due to improper rolling and penetration.

Many of these failures are due to frost action in the subgrade, or improper drainage, which permits this frost to heave up the surface, or the gradual accumulation of moisture in poorly drained places in the subgrade, which destroys the support of the wearing surface through no fault of that surface.

Other failures were plainly due to improper mixing or penetration, from careless workmanship; others to the careless use of dirty aggregate, so full of loam, silt or dust that the binder was not able to reach the stone, or the aggregate was badly graded; and some other failures are entirely due to bad or improperly heated binder. One sheet asphalt failure was due to the use of glacial silt, ground as fine as cement as the only aggregate.

I know the one piece of penetration surface, in which three experimental sections were laid, each of about 500 ft. In these sections were used trap rock or very hard basalt, limestone, just as average grade and sandstone of good character, while on all the rest of the road, granite of good grade was used. This surface was laid in three layers of 2 in., 2 in. and 1 in. Two years after opening, a seal coat was put on and nothing has been done with it in the past six years. The same materials were used on the seal coat and I can distinguish no difference at all in these four sections of pavement. This road has carried up to 400,000 cars and trucks per season of eight months and the pavement is in perfect condition; but, it is laid on a perfect subgrade and 18 in. of Telford.

Between the entrance to a ferry slip and the foot of a hill 1½ miles long, brick paved, on concrete base, with grades from 5% to 8%, there is a rock fill 300 feet long. As this fill was expected to settle, it was decided to lay a temporary cinder surface on it. Three inches of clean steam cinders were spread and rolled with a 1000 lb. roller and one gallon per yard of bituminous binder was applied and lightly covered with cinders. Two years later, another application of ½ gallon per yard of binder was made and lightly covered with cinders and at the end of another two years, this 300 ft. of temporary surface is in perfect condition and more than 330,000 cars and trucks used it during the last eight months, and yet, the crushing strength of cinders is not great.

In eastern Ohio and Western Pennsylvania, much slag has been used and when treated about like limestone, has made good surfaces. Many surfaces have been laid with crushed gravel, which is, of course, just like good crushed stone, if properly screened and washed before crushing. The usual specification for this aggregate being 60% more, of material to have angular fragments. But, some surfaces have been laid with gravel without crushing and when this aggregate was clean, properly sized and bonded, these surfaces have been good. In Massachusetts, and other New England States, this uncrushed gravel aggregate has been extensively used, in the so-called tar concrete pavements, with success when the workmanship was good, and many old gravel roads have been successfully surfaced with only gravel aggregate. Good workmanship means more in bituminous macadam surfaces than mineral aggregate does.

It would seem much wiser for the engineer to carefully study all available local mineral aggregate and prepare his specifications to permit the greatest possible use of it in his surfaces, than to fall into the easier method of copying standard specifications and so compelling contractors to import these aggregates and so greatly increase costs. Better put this extra money in your subgrade work, for that is really your road.

The Carmichael Waterproofing Co. of Toronto has been awarded the contract for the roofing and sheet metal work for the new Mount Royal Hotel, Montreal. This firm has completed similar contracts to numerous large buildings in Canada from coast to coast. A built-up Barrett Specification bonded roof 70,000 sq. ft. in area will be installed on this hotel.

*Paper read at the Annual Convention of the American Road Builders' Association, Chicago.

Engineer's Library

GOVERNMENT OWNED AND CONTROLLED COMPARED WITH PRIVATELY OWNED AND REGULATED PUBLIC UTILITIES IN CANADA AND THE UNITED STATES—Report made to the National Electric Light Association by William S. Murray, of Murray & Flood, Consulting Engineers. Paper; 8 by 11 in.; pp. 223; profusely illustrated.

Mr. Murray, who was in charge of the super-power survey for the United States Government on the Atlantic seaboard between Boston and Washington was retained by the National Electric Light Association to report on the operations of government owned public utilities with special reference to the Hydro-Electric Power Commission of Ontario. The results communicated in this elaborately gotten up report are hostile to government operation.

PRELIMINARY TOPIC OUTLINE OF THE ECONOMICS OF HIGHWAY TRANSPORT—By Lewis F. McIntyre, Assistant Professor of Civil Engineering, University of Pittsburgh. Paper; 6 by 9 in.; pp. 59.

This Bulletin forms a part of a topical outline in the economics of highway transport and is issued by the Highway Transport Education Committee of the Society for the Promotion of Engineering Education as a part of their work in furthering highway transport education. It is hoped that it may assist engineering students in forming a more definite idea of the field of highway transport and aid them in getting a vision of the opportunities for future employment in this field. It is also hoped that in those colleges where courses in highway transport are being given, or are contemplated, it may assist teachers in this subject in the formation of adequate courses with a minimum of duplicated effort on their part.

TRANSACTIONS AND YEAR BOOK OF THE UNIVERSITY OF TORONTO ENGINEERING SOCIETY—Published by the Society. Paper; 6 by 9 in.; pp. 166; Illustrated.

This is the second number of the revived Transactions of the University of Toronto Engineering Society following the suspension of the monthly journal "Applied Science" published for several years prior to and during the war. This volume which is dedicated to the School of Science men who gave their lives in the great war, contains a dozen or more papers presented to the Engineering Society and its constituent clubs, or specially contributed to the Transactions.

The papers comprise the following: Provincial Highways, by George Hegarth, Chief Engineer of Highways, Department of Public Works of Ontario; Engineering and Trade Within the Empire, by Brig.-Gen. C. H. Mitchell, Dean of the Faculty of Applied Science and Engineering, University of Toronto; The Engineering Institute of Canada, by George T. Clark, Designing Engineer, Toronto Harbor Commission and past chairman of the Toronto Branch of the Engineering Institute of Canada; Organization, by Professor E. A. Allent; American Architecture, by John M. Lyle; Artistic Design of Bridges, by Charles Fowler, Chief Engineer of the Detroit-Windsor Bridge; The School of Engineering Research, by Professor M. C. Boswell; Special Water Power Lectures, a review by Professor R. W. Angus; Some Principles Controlling the Use and Design of Hydraulic Turbines, by Lewis F. Moody, Philadelphia; Essay on Fire Prevention, by T. S. Glover, Class of 1922; The Canadian Institute of Chemistry, by Professor J. Watson Bain; Stress Analysis, by Professor T. R. Loudon.

In addition to the technical papers there is a great deal of information concerning the operation of the clubs and societies connected with the Faculty of Applied Science and Engineering.

MECHANICAL ENGINEERS MEET IN ATLANTA

ATLANTA, Ga., will be the convention city of the American Society of Mechanical Engineers, who will hold the 1922 annual Spring meeting in the South, May 8-11, inclusive. Three days will be given over to technical sessions and visits will be paid to various points of interest in the district, such as the University of Virginia, textile mills at Greenville, S.C., steel mills at Birmingham, Ala., and Muscle Shoals. The program of papers to be presented includes a variety of subjects of interest to members, such as textile machinery, material handling equipment, fuel wastes, boiler tests, water power development, steam engine efficiency, centrifugal castings, welding, etc. The headquarters of the convention will be at the Piedmont Hotel.

Letter to the Editor

CLAIMS TO BE VALID MUST BE PROVED.

Sir—The article entitled "Developments in Photographic Surveying" by M. P. Bridgland, which appeared in the "Canadian Engineer" April 4, 1922, may possibly be of some interest to photographers, but the system described cannot be applied to topographical surveying in a practical way unless by eliminating the two main objectives of such surveys—efficiency and economy. The foremost reason for stating this goes beyond mere discussion or individual preference and is found in the many years of continual test and observation which have shown the impracticability of photographic "surveying." The "Engineering News-Record" in an editorial in the issue of April 6, 1922, tells us that engineers are the principal map-using class and they are the people most directly concerned in the matter of how our maps are made. If this is true then engineers are in the best position to judge of map requirements—and not photographers.

The most important part in Mr. Bridgland's paper to which I desire to direct the attention of your readers is where reference is made to the superiority of the camera method as compared with the plane table. Professor Anderson, in a previous article on the same subject, arrives at the same conclusion. The former sums up with the following statement:

"The precision is that of a good plane table survey but with the advantage that many more points are plotted and the contouring is done by the surveyor in the office, with views of different stations continually before him, while with a plane table this comparison is entirely wanting."

The article by Professor G. R. Anderson was published in the "Canadian Engineer" under the title "Stereographic Measurement," as long ago as March 28, 1912. His concluding remarks were as follows:

"The great simplicity of this method as compared to that of plotting by means of the plane table will be at once apparent, and the precision secured is much superior and comparable to that of any other method of survey in ordinary country."

These two gentlemen presumably hold responsible positions and documents signed by them and published in an engineering journal will naturally be accepted as authentic and reliable. I have good reasons, however, for questioning the above two statements, and would respectfully ask Mr. Bridgland and Professor Anderson if they are prepared to support them by a practical test in the field? If they have sufficient confidence in their instrument to prove by actual demonstration its superiority to the plane table? I will even encourage them to the extent of entering the contest without a fully equipped plane table merely using a military traverse instrument minus telescopic alidade and stadia. There are no insuperable difficulties to arranging such a trial; both instruments could be given a fair chance under engineering supervision and an impartial judgment arrived at without endless discussion.

P. J. BARRY.

Winnipeg, April 21, 1922.

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CHLORINATION, TASTES AND ODORS

IN OUR issue of last week there was included the tentative program of the 42nd annual convention of the American Water Works Association. The question of tastes and odors in water supplies has been regarded as of such importance that a symposium has been prepared. Several technical papers will be presented at the meeting and leading sanitarians of the day are expected to take part in the discussion.

One of the chief questions that sanitarians are called upon to investigate is the occurrence of taste and odor in water. Taste resulting from excessive algae growths are not common in this country, because storage and impounding reservoirs are not extensively used; and the waters of the Great Lakes, on account of the continuously moving currents, do not favor the growth of these organisms in sufficient numbers as to cause taste. The chief problem, which at times is a very real one, is the taste in water following the application of chlorine for sterilization purposes. The cause of this is not definitely known, but recent researches have indicated that it is the result of the formation of chemical compounds designated as chloro-phenols. The discharge of industrial effluents containing phenols into rivers and streams from which municipal water supplies are drawn, is held to be largely responsible for this. Assuming that this is the cause, legislation should be framed to prevent such indiscriminate discharge of effluents into city sewerage systems. It is likely that many industrial plants could recover by-products from their trade wastes which would not only compensate them for labor and expense involved, but might actually be instrumental in preventing taste in water treated with chlorine.

In the last report of the Milwaukee Sewage Commission, the question of the relationship of phenols and chlorine to taste was given considerable space. It was demonstrated at Milwaukee that a combination of these two chemicals produced a water practically undrinkable, and after an exhaustive survey had been completed, it was found that the effluents from the gas and coke plants in the city contained phenols in large quantities, and that under certain meteorological conditions the river waters containing these wastes mixed with the lake water and ultimately caused objectionable taste in the city supply. By diverting the flow of the effluents, taste was completely removed.

No figures appear to be available as to what amounts of phenol and chlorine are necessary to produce taste, and it would appear to offer considerable scope to research chemists, particularly on water works plants. It is interesting to recall that in dealing with the New York supply, Brush recently found that tastes and odors were overcome by the use of excess chlorine as advocated by Houston in England. In New York, where taste occurred following the presence of algae in the reservoirs, the chlorine dose was raised from 0.3 to 0.7 parts and taste practically eliminated.

It may be found that when taste occurs from chloro-phenols, there are definite quantities of each reagent which combine and cause taste, and that a decrease or increase of chlorine may be the solution. In England, Houston definitely recommended super-chlorination, followed by de-chlorination of the excess chlorine with neutralizing reagents as a solution to taste problems. It is safe to state that with so many of our leading chemists working on this interesting problem, the solution will ultimately be forthcoming and a further advance made in the field of sanitary science.

RAILWAY ELECTRIFICATION DISCUSSED AT OTTAWA

ELECTRIFICATION of railways as an issue to be faced in the near future in this country was brought vividly to the attention of the House of Commons recently by Mr. Deslauriers, member for St. Mary's. In addition to pointing out the magnificent electrical resources of this country and their bearing on the solution of the fuel problem, Mr. Deslauriers called the attention of the House, and of the country generally to the fact that there is an annual fire loss in forests of from ten to fifteen million dollars arising from forest fires many of which are kindled by sparks from locomotives. Such losses, said the speaker, might be completely abolished under electric operation.

Mr. Deslauriers made the assertion that for an identical trip under the same load occupying the same time, the cost of the motive power for an electric locomotive is as 88 to 200 compared with that for a steam locomotive and that the maintenance costs are as 8 to 18. He wished to know why the railways in the valley of the St. Maurice having 800,000 h.p. available should not be electrified. In view of his understanding that the Canadian Pacific Railway a couple of years ago almost concluded a contract with the Shawinigan Water & Power Co. for the electrification of its Montreal to Quebec line, he asked why the lines in the neighborhood of Montreal had not been converted to electric operation.

The declaration of Hon. W. C. Kennedy, Minister of Railways, in concluding the debate, to the effect that the Board of Management of the National Railways is keenly alive to the situation is of interest. The Board feels, however, that in Canada the change at the present time would entail a very large expenditure, which the result of investigations so far made would scarcely warrant. It thus appears that those in charge of the National Railways are entirely sympathetic, and that, when the right time comes, they will do their part.

In view of the economic condition of the country and the large capital expenditure involved in electrification, amounting to from forty to fifty thousand dollars a mile, the attitude of the government and of the directing heads of the National Railways is none other than sound. For some years the Canadian Pacific Railway has been consid-

ering the question of electrification, but so far has not discovered any one section of its line on which electrification might profitably be made. In this finding we have, therefore, corroboration of the views of the Board of Management of the National Railways.

WINNIPEG AQUEDUCT UNDERDRAINAGE

AT A recent meeting of the city council of St. Boniface, Man., there was some discussion of the effect of alkali on certain portions of some of the sewers in that city. Some members of the council expressed an opinion that the damage was due to poor workmanship rather than to any other cause. The city engineer and one of the aldermen, in order to combat this statement, referred to the fact that the Shoal Lake aqueduct of the Greater Winnipeg Water District, one of the best examples of concrete construction in Canada, had suffered from alkali action.

A reporter who was present at the meeting and who apparently was poorly informed regarding the history and extent of the Winnipeg aqueduct alkali troubles, wrote an article intimating that alkali is destroying the entire aqueduct and this article was reprinted by numerous daily newspapers throughout the country, with the result that many engineers who know the history of Winnipeg's past alkali troubles received the impression that fresh and more serious difficulties had been encountered. This is incorrect, and the engineers in charge of the District's affairs have reason to believe that the type of underdrainage constructed last year has proven effective in preventing alkali-bearing groundwaters coming into contact with the concrete.

It is possible that additional drainage may be required this year or next, depending upon further observations that will be made within the next few weeks, but if the commissioners in charge have to undertake this additional drainage, it can be considered as nothing more than the logical step that they should take to protect the structure.

PERSONALS

ALEX. KOIVU has been appointed road commissioner for McIntyre Township.

J. J. C. BRADFIELD, chief engineer of the proposed bridge over Sidney Harbor, Australia, is visiting Canada on route to England. Mr. Bradfield will visit Ottawa for the purpose of interviewing representatives of Canadian firms who may wish to bid on the work. Tenders for the construction of the bridge will be received until October 31, 1922.

J. B. IELME of Smith's Falls, Ont., who graduates this year in architecture from the Faculty of Applied Science, Toronto University, has been awarded a Provincial Scholarship in town planning by the Department of Education. The award which is tenable for one year, provides for travel and study in France on the subject of Town and Regional Planning and Housing.

H. P. BORDEN has opened an office in the Hoppe Chambers, Ottawa, as a consulting engineer, specializing in bridges and structures in steel and reinforced concrete. Mr. Borden graduated from McGill in 1902 with the degree of B.Sc., his first position after leaving college being in the Bridge Department of the C.P.R. He was later assistant chief engineer of the Locomotive & Machine Co., Montreal, and architectural engineer for the C.P.R. In 1908 he joined the staff of the Board of Engineers, Quebec Bridge, as assistant engineer and secretary, and was later appointed assistant to the chief engineer. On the death of C. C. Schneider in 1916, Mr. Borden was appointed to fill the vacancy on the Board of Engineers, which position he held until the completion of this work in 1918. From 1919 to 1921 he was engaged by the Dominion Government in a consulting capacity.

HON. DR. JAMES H. KING, the new Minister of Public Works in the Dominion Government is a doctor by

profession, practicing at Cranbrook, B.C. The new minister who was born at Chipman, N.B. on January 18, 1873.



was educated at St. Martins Academy, and graduated from McGill University, Montreal. Dr. King first began practicing at Andover and St. John, N.B., but after three years he left the Maritime Provinces and went West to Cranbrook, B.C., where he has resided ever since. Dr. King began his political career in 1903 when he was elected to represent Cranbrook in the Provincial Legislature. He represented this constituency until 1907. He was liberal candidate for Kootenay at the general elections in 1911, but was defeated, however, in September 14, 1916, he was again returned to the Provincial Legislature and accepted the portfolio of Public Works in the government formed in November 29, 1916. The appointment was confirmed in December, 1916, when he was re-elected member for Cranbrook. At the general election last December Dr. King was elected member of Dominion Parliament and last February was appointed Minister of Public Works. He has always taken a deep interest in educational affairs and is one of the founders and governors of the American College of Surgeons, Chicago.

He has always taken a deep interest in educational affairs and is one of the founders and governors of the American College of Surgeons, Chicago.

POWER SITUATION ALONG THE T. & N. O. Ry.

COMMISSIONERS of the Temiskaming and Northern Ontario Railway are taking every precaution to retain control of the necessary rights to assure the full amount of energy that may be required at some future date in connection with the electrification of their road, but they have no desire to stand in the way of the Hollinger Consolidated Gold Mines of Porcupine being given rights to develop whatever additional hydro-electric energy which may be required by that company.

It is stated there is more energy running to waste at the present moment on the Abitibi River than will ever be required by all three concerns now involved, namely: the T. & N. O. Railway, the Hollinger Consolidated Gold Mines, and the Abitibi Power and Paper Co.

In the meantime, the Northern Canada Power Co. is rushing work in connection with developing an additional 7,000 h.p. on the Matagami River, with which to supply the mines of the Porcupine. If this will meet the full requirements of the Porcupine field, it may not be necessary for the Hollinger to engage in power developments on its own account.

Thomas Adams, town-planning expert for the Dominion Government, is in London, Ont., drawing up a city plan. Mr. Adams, in conjunction with city engineer H. A. Brazier, will make a general survey of the city in connection with the proposed zones.

The Canadian Bridge Co., contractors for the steel highway portion of the Johnson Street bridge superstructure, will shortly commence the erection in Victoria of one of the largest steel cranes ever placed in operation on the Pacific Coast. The crane has a 90-ft. boom and a sweep of 180 ft.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Queenston Heights, Ont., sub-grading and construction of macadam road-way	May 24	Apr. 18
Bridgewater, N.S., erection of Fire Hall	May 8	Apr. 18
Pembroke, Ont., erection of hospital ..	May 9	Apr. 11
Ontario, Province of, various work on Provincial highways	May 11	Apr. 11
Toronto, Ont., work on Riverdale Branch Technical School	May 3	Apr. 18
Crystal Beach, Ont., sewer and disposal plant	May 5	Apr. 18
Toronto, Ont., construction of Gerrard St. bridge	May 16	Apr. 18
Francis, Sask., road work	May 5	Apr. 25
Chatham, Ont., supply and construction of steel sheet piling baffling system in water works sedimentation basin	May 10	Apr. 25
Montreal, Que., erection of Notre Dame Hospital	May 15	Apr. 23
Ford City, Ont., erection of school	May 10	Apr. 25
Lachine, Que., supply of stone, sand, cement, clay pipe, bitumen and paving of 18th Ave.	May 4	Apr. 25
Newmarket, Ont., erection of arena building	May 10	Apr. 25
P. E. I., Province of, grading and concrete structures	May 19	Apr. 25
Quebec, Province of, road construction	May 12	Apr. 25
Winnipeg, Man., three 1000 k.v.a. transformers	May 15	Apr. 25
York Tp., Ont., concrete culverts	May 13	Apr. 25
York Tp., concrete sidewalk and grading	May 6	Apr. 25

BRIDGES, ROADS AND STREETS

Berthier, Que.—Tenders for the construction of the Ralston bridge in steel and concrete, will be received at the office of J. A. A. Lavallee, Sec.-Treas., Berthier, until 12 o'clock noon, Wednesday, May 3. Plans and specifications at office of secretary-treasurer.

Bonaventure, Que.—Town Council considering the travelling of roads.

British Columbia, Province of.—Tenders for construction of approximately nine miles of the Ymir Road South of Nelson, will be received until noon, Wednesday, May 3, by Hon. W. H. Sutherland, Minister of Public Works.

British Columbia, Province of.—Tenders for new formation and paving of the Trans-Provincial Highway, Chilliwack district (2,074 miles), will be received at the office of Hon. W. H. Sutherland, Minister of Public Works, until noon, May 9. Plans and specifications may be seen at the office of P. Philip, Public Works Engineer, Department of Public Works, Victoria, and at the District Engineer's office, Court House, New Westminster.

Chatham, Ont.—Road construction program of Kent County Council for this year includes 12 miles of pavement to be located near Pain Court, Wallaceburg, Thamesville,

Dresden, and along the Dover-Chatham Townline. All of these pavements will be of permanent concrete. Road Supt., L. A. Pardo, Chatham.

Cobalt, Ont.—Mining interests in this district are taking steps to encourage the Ontario Government to improve the road to the South Lorrain area.

Cornwall, Ont.—Doran Construction Co., of Ottawa, has been awarded contracts for building roads and culverts east and west of Cornwall, and also two bridges in the township of Charlottenburg and north or Elmsley in the vicinity of Perth.

Fredericton, N.B.—Provincial Government will carry on permanent road construction this year between Musquash and Lepreau, between Nerepris and Welsford, and near Buctouche. Repairs to the Rothesay road will be made at an early date.

Halifax, N.S.—Contract awarded by City Council to the Stephen Construction Co., of this city, for the construction of curbing and sidewalks between \$125,000 and \$150,000.

Hamilton, Ont.—City Council plans to pave one side of Main St. City Engineer, E. R. Gray.

Hamilton, Ont.—Capitalized at \$150,000 the Albion Paving and Construction Co., Ltd., has been granted a Dominion charter. The company, incorporated for the purpose of carrying on a general contracting and construction business, has for its incorporators A. M. Spafford, W. H. Latimer, D. Morsman, M. A. Gallagher and A. H. Joyce, all of Toronto. The head office of the company will be in this city.

Kenora, Ont.—Peter Heenan, M.P.P., announced that an effort will be made this summer to grade several miles of the highway west from Keewatin.

Kingsville, Ont.—Contract for labor and materials necessary for the construction of reinforced concrete base and stone filled asphalt, together with necessary excavating curbing, etc., has been awarded to Merlo, Merlo & Ray, Ltd., Ford City, Ont.

Kitchener, B.C.—Plans for road construction in this vicinity are on file at the Provincial Department of Public Works. District Engineer, William Ramsay, Nelson.

Kitchener, Ont.—Tenders will be received by S. Shupe, City Engineer, until 5 p.m., Monday, May 8, for the construction of approximately 10,000 sq. yds. of bituminous penetration pavement, on a crushed stone base. (See official adv.).

Lindsay, Ont.—Tenders closed May 1 for the construction of granolithic sidewalks for the year 1922, said sidewalks to comprise 5,000 lin. ft. or upwards, as authorized. Town Clerk, W. R. Alley.

London, Ont.—Superintendent Charles Forrester, of the Grand Trunk Railway, announced that construction work on the overhead bridge on the north road to Springbank will be started immediately by the company.

Loretteville, Que.—Town Council plans construction of concrete bridge.

Malahide Tp., Ont.—Tenders, addressed to Jas. A. Bell & Son, Civil Engineers, Courthouse, St. Thomas, will be received until noon, Friday, May 5, for grading Silver Creek Hill. Approximate quantity of excavation, 13,000 cu. yds. Plans and specifications may be seen at office of the engineers, or at the office of Frank Pineo, county road superintendent, Courthouse, St. Thomas.

Matsqui, B.C.—Council considering construction of concrete walk on St. Olaf St. Clerk, John Le Feuvre.

Montreal, Que.—The laying of concrete blocks as a temporary sidewalk in the outlying wards of this city has

been recommended to the City Council by the executive committee.

Montreal, Que.—The opening up of St. Joseph Blvd., from Henri Julien Ave. to Papineau Ave., will be considered by City Council, the road to be of asphalt with a concrete base.

Montreal, Que.—The paving program for this year will be ready shortly and it is anticipated to total over a million dollars. \$41,900 has been voted for the paving of Wellington St., from St. Patrick to Congregation Sts.; \$140,000 is available for the completion of the paving of St. Denis St., from Carrieres to Isabeau Sts.; \$70,000 for the paving of Cote des Neiges Road; and \$32,000 on the appropriation made for paving Laurier Ave.

Ontario, Province of.—Construction work will shortly be resumed in the Hamilton district on the provincial highways. Contracts on the Winona-Hamilton road and Brantford highway have already been let.

Ontario, Province of.—Tenders will be received by W. A. McLean, Deputy Minister of Highways, until 12 o'clock noon, Wednesday, May 10, for the supply of 40 and 60 per cent road oil.

Ottawa, Ont.—Ald. McElroy presented a petition to City Council for the paving of Renfrew Ave.

Owen Sound, Ont.—Contract has been awarded by the Provincial Highway Department to W. C. Chambers, of Harrison, for grading the Provincial highway north of Owen Sound to Dornoch, work to start about May 1.

Owen Sound, Ont.—Suburban Area Commission plans construction of a high level bridge at the point on the North Gravel Road where Maxwell's creek crosses, and also the construction of a 9-ft. concrete roadway. Commission also plans to repair other sections of roadway, including the St. Vincent, Sarawak and Leith roads.

Portage la Prairie, Man.—Tenders will be received by D. McGowan, Sec.-Treas., until 2 o'clock, Tuesday, May 2, for hauling materials and building six timber bridges.

Quebec, Province of.—Provincial Government has been asked to construct a bridge over the Saguenay, near Chicoutimi.

Quebec, Province of.—The preliminary plans for the Vaudreuil bridge, one of the Perrot Island bridges, have been fully studied by the engineers, according to Ivan Vallee, chief Engineer, of the Department of Public Works. The Provincial Cabinet will now take up the matter and decide when tenders for the bridge will be called for.

Regina, Sask.—Approximately \$1,570,000 will be spent by the Provincial Government this season on roads and large bridges, according to J. G. Gardiner, Minister of Highways, the expenditure to be apportioned as follows: Roads constructed under the Federal aid scheme, \$900,000; large steel and concrete bridges, \$120,000; main market roads, \$550,000.

St. Hyacinthe, Que.—Council contemplates construction of pavements and sidewalks.

St. Jacques, Que.—Council will call tenders for construction of bridge estimated to cost \$18,500.

St. Thomas, Ont.—Wellington St. is soon to be repaved with asphalt. Hughes St. north will also be paved with asphalt. City Engineer, W. C. Miller.

Sherbrooke, Que.—Ratepayers approved of by-law passed by City Council providing for the borrowing of \$75,000 for the levelling and paving of King St. West, from Montcalm bridge to the city limits. Sec.-Treas., E. C. Gatien.

Sherbrooke, Que.—By-law passed by City Council providing for borrowing of \$55,000 for reconstruction of Dufferin bridge in concrete and steel, has been approved by ratepayers.

Shuniah, Ont.—Municipal Council proposes to expend approximately \$22,000 on road improvement this summer. Road Commissioner, Alex. Kolva.

Stratford, Ont.—The firm of W. L. Malcolm, of Kingston, has been awarded the contract for concrete curb and gutter construction. Prof. Lindsay Malcolm, of Queen's University, will supervise the work.

Sydney, N.S.—City Council may erect a bridge at Argyle St. at cost of \$12,000.

Three Rivers, Que.—An expenditure of \$50,000 on street improvements is planned by the Council.

Tillsonburg, Ont.—Lisgar Ave. will be paved. Clerk, A. E. Raynes.

Toronto, Ont.—Board of Control recommended to City Council the adoption of the Provincial good roads scheme for this district which calls for an expenditure of \$5,000,000, of which the city would have to pay \$1,000,000.

Toronto, Ont.—Following contracts awarded for construction of pavements: Asphalt-Austin Crescent and Austin Terrace, Godson Contracting Co., Ltd., Toronto; Beachview Crescent, Gerrard St. East, George St., Hillingdon Ave. and Fairmount Crescent, Kilmer & Barber, Ltd.; Blackthorn Ave., Godson Contracting Co., Ltd.; Cluny Drive and Dewson St., Constructing & Paving Co., Ltd., Toronto. Bitulithic—Beachview Crescent, Belhaven Road, Brookside Drive, Caithness Ave., Glebeholme Boulevard, Glebeholme Ave., Wrenson Road, Warren Paving Co. of Ontario, Ltd., Toronto; Bowmore Road, Commissioner of Works. Concrete—Briar Hill Ave., Commissioner of Works.

Victoria, B.C.—City Council awarded contract for completion of the Johnson St. bridge to the Canadian Bridge Co., of Walkerville, Ont., for \$213,600.

Waterloo, Ont.—Town Council adopted recommendation of the Board of Works for the laying of pavements on nine streets. Town Engineer, Chas. Moogk.

Whitby, Ont.—There is a strong movement here to go ahead this year with the paving of the two portions of Brock St. now forming part of the Provincial Highway from Whitby to Lindsay, between the Canadian National and Canadian Pacific stations.

Winnipeg, Man.—City Council referred back for further consideration recommendations for the construction of six crossings on Sherbrooke, Maryland, Graham and Rupert Sts.

Woodstock, Ont.—G.T.R. has decided to make extensive improvements this spring to the three bridges which span its tracks. Six-ft. steel bridges are to be added to the Wellington and Bay St. spans, and concrete abutments are to be added to the latter.

Woodstock, Ont.—By-law was introduced at Council meeting providing for the construction of a 4-ft. concrete sidewalk on the south side of Anne St. Tenders will be called for concrete walks, curb and gutters to be constructed this year. Clerk, James C. Haight.

WATER, SEWAGE AND REFUSE

Brockville, Ont.—Town Council intends to construct a sewer on Front Ave., between Park St. and Ormond St., at a cost of \$2,400. Town Clerk, Geo. K. Dewey.

Chatham, Ont.—Board of Water Commissioners are receiving tenders until May 10 for the steel sheet piling in connection with the baffling system at the sedimentation basin of the water works.

Goderich, Ont.—At the instance of the Provincial Board of Health a formal order has been served on the civic authorities demanding the improvement of the town's water supply system.

Guelph, Ont.—Plans for the proposed new trunk sewer from Gordon St. to the disposal works have nearly been completed by City Engineer F. McArthur.

Halifax, N.S.—City Works Committee on April 22 received and opened ten tenders for the laying of a new water main from the corner of Quinpool Road and Robie St. in and down Cogswell St. to Brunswick. Tenders were referred to City Engineer Doane.

Hamilton, Ont.—City Council intends to construct pipe sewer on King William St. at cost of \$1,460. City Engineer, E. R. Gray.

Hamilton, Ont.—The superintendent of the water commission has been instructed to secure estimates on the cost of extending the intake pipe at the lake 150 ft.

Hamilton, Ont.—Tenders will be received by S. H. Kent, City Clerk, until 5 o'clock p.m., Monday, May 22, for the construction of Section No. 4, Western Storm Overflow Sewer. (See official adv.)

Kamloops, B.C.—Contract for construction of east end sewer awarded to the Kamloops Plumbing & Heating Co. the contract price being \$47,980. Following tenders were also received: Vickers Contracting Co., Ltd., \$98,600; Cotton Co., Ltd., \$72,000; Broley & Martin, \$48,287; A. D. Creer, \$68,040; Nick Cosco, \$56,900; Robertson & Rendell, \$59,149; G. K. Williams and J. W. Bye, \$51,457; Dominion Construction Co., Ltd., \$89,964; Nickson Construction Co., Ltd., \$68,50; G. Woodward, \$63,450; G. C. Hopper, \$56,873.

Ladner, B.C.—Contract for supply of pipe for the Westham water supply awarded to Clement and Lambert by Council.

Midland, Ont.—Following is a list of the tenders received for construction of sewers on William and other streets: J. Toole & Son (catch basins not included), vitrified pipe, \$67,000; P. Molran, London, concrete, \$53,185.37, vitrified, \$56,125.58; Ruscie Bros., Toronto, vitrified, \$53,981; Bath & Anderson, concrete, \$51,174.72, vitrified, \$53,674.72; Bumbaca Bros., concrete, \$48,392.75, vitrified, \$49,392.75; Trew Bros., concrete, \$44,237.70, vitrified, \$46,737.70; Curran, Briggs Co., Toronto, concrete, \$43,645.50, vitrified, \$46,418.12; Town of Midland, concrete, \$43,558, vitrified, \$45,850.36; F. F. Fry, Toronto, concrete, \$39,214, vitrified, \$41,714.32.

Montreal, Que.—Contract for the construction of sewers on Park extension awarded to Fillon & Brothers, at approximately \$100,000.

Montreal, Que.—A proposal to spend \$4,000,000 on the construction of a huge main sewer, that would serve the whole of the northern section of the city will come before the Council on a motion prepared by Ald. Bray.

Montreal, Que.—City Council has approved construction of following sewers: Lanoraie St., from Cremazie Road to Abraham St., \$19,842.50; Birman St., from Cremazie to Beaumont, \$29,381.52; Ball St., from O'Shaughnessy St. to Stuart St., \$1,785.25; from O'Shaughnessy to St. Adele St., \$796.50; and from St. Adele to Bickerdike, \$776.25. Another street from St. Adele to Lanoraie St., \$1,950; and Hopper St., from Birman St. to Allen St., \$783.50.

North Bay, Ont.—Board of Works recommended construction of storm sewer on McPhail St., Whitson St., from Rock to McIntyre St., and from Rock east of Metcalf St., along McIntyre St. to T. & N. O. Railway. Clerk, Wm. N. Snyder.

Ottawa, Ont.—An immediate start is to be made on the excavation work of the addition to the Lemieux Island water supply pipe.

Quebec, Que.—Waterworks Committee awarded contracts for supplies amounting to \$50,000, including following: Valves, Drummond, McCall & Co., Ltd., at \$9.85, \$16.85 and \$28; cast iron pipe, Canada Iron Foundries, 4-in., \$54.50, 6, 8 and 12-in., \$50; lead pipe, Mechanics Supply Co.; pig lead, Crane, Ltd.; clay pipe, Standard Clay Products; cast iron, Terreau & Racine.

St. Raphael, Que.—Council plans construction of an aqueduct at a cost of \$12,000.

Saanich, B.C.—Municipal Council plans to submit sewer by-law to ratepayers about the middle of July. Clerk, H. S. Cowper.

Sherbrooke, Que.—Ratepayers approved of by-law passed by City Council providing for borrowing of \$115,000 for the construction and laying of sewers. Sec. Treas., E. C. Gatién.

Toronto, Ont.—Construction of sewer in Richard Ave. is proposed.

Toronto, Ont.—Contract awarded to A. Cavotti, Toronto, for laying and jointing of 6-in. water pipes in Nursewood Road.

Toronto, Ont.—Contract for construction of sewer in Strathmore Boulevard, from Woodington Ave. to Glebe-mount Ave., awarded to W. E. Taylor, at \$2,387.

Toronto, Ont.—Works Commissioner Harris recommended the laying of water mains on Bellefair Ave., St. Clair Ave. east of Hudson Ave., Edna Ave., Morton road, Bingham Ave., Davenport road, east of Greenlaw, Regal road, east of Oakwood Armadale Ave., and Wolverleigh Boulevard.

Toronto, Ont.—Tenders will be received, addressed to C. Alfred Maguire (Mayor), Chairman, Board of Control, City Hall, until 12 o'clock noon, Tuesday, May 16, for one four-million Imperial gallon centrifugal pump. Specifications may be obtained at the Works Department, Room 12, City Hall.

Toronto, Ont.—Tenders will be received, addressed to C. A. Maguire (Mayor), Chairman, Board of Works, until noon, Tuesday, May 9, for the laying and jointing of 6-in. water pipes in the following streets: Claude Ave., Elmer Ave., Garfield Ave., Glendale Ave., Haslett Ave., Merrick Ave., Patterson Ave., Rhyt Ave., St. Germain Ave., Simpson Ave., Mount Pleasant Road, Lighthouse Ave. and Ingham Ave. Specifications may be obtained at Room No. 320, City Hall.

Toronto, Ont.—Tenders will be received, addressed to C. A. Maguire (Mayor), Chairman, Board of Control, until noon, Tuesday, May 9, for the construction of the following sewers: Western Harbor Development Drainage System—Section 1—2000 ft. east of Parkdale Drive to 1,478 ft. farther east; Section 2—Parkdale Drive to Jane St., Section 3—Parkdale Drive to Jane St.; Margueretta St., from College St. to Bloor St.; Ardagh St., Durie St. to Jane St. Specifications may be seen at the Works Department, Room 6, City Hall.

Vancouver, B.C.—Plans for a storm sewer, running along the Collingwood Valley from Earls road to Aberdeen St., in South Vancouver, were approved by the Vancouver and Districts Joint Sewerage and Drainage Board. The board's engineer was instructed to make an estimate of the cost.

Waterloo, Ont.—Water and Light Commission will be asked to extend the water main on Rathbourne Ave., from Arthur St. to Blandford St.

West St. Paul R.M., Man.—Tenders will be received by H. I. Thompson, Sec. Treas., Middlechurch, Man., until May 10 for drilling two wells on Rossmore Ave.

Winnipeg, Man.—City Council authorized construction of sewer in Balfour St.

Winnipeg, Man.—City Council authorized water main construction aggregating approximately \$36,000. City Engineer, W. P. Brereton.

York Tp., Ont.—Following contracts awarded for construction of 6-in. water mains: Bickness Ave., Peter Mohan; Dunvegan Road, A. Cavotti; Russell Hill Road, A. Cavotti; Forest Hill Road, A. Cavotti; Lacey Ave., W. E. Taylor; Schell Ave., A. Cavotti; Burgess Ave., Peter Mohan; Nealon Ave., Peter Mohan; Logan Ave., Peter Mohan; Don Mills Road, Gordon Thompson; Leroy Ave., Peter Mohan.

LIGHT, HEAT AND POWER

Cloverdale, B.C.—Plans are being prepared by Municipal Engineer J. O'Hara for a street lighting system.

Donnacona, Que.—The construction of a storage dam is planned by the Donnacona Paper Co.

Edmonton, Alta.—Tenders addressed to the city commissioners will be received until 1 p.m., Monday, May 15, for the supply of two automatic induction feeder voltage regulators, 2,300 volts; two 2,000 k.v.a. 13,200-6600-2200 three phase, 60 cycle, w.c. transformers. Specifications may be obtained at the office of the Superintendent of the Electric Light Department, Second Floor, Civic Block.

Halifax, N.S.—Following tenders were opened by the Civic Works Committee for installation and supplies for the new street lighting service, some of the tenders being for complete installation and others for partial installation and fixtures, etc.; Northern Electric Co., Ltd. (a) \$85,750.72, (b) \$72,344.06, (c) \$75,354.06, (d) \$82,700.13; W. W. Hoyt, \$112,054; Canadian General Electric Co.,

\$48,050; Farquhar Bros. \$56,875 (no wire included); Jas. Graham, Windsor Foundry Co. and F. S. Coombes, detailed prices on standards, etc. Tenders were referred to City Engineer Doane.

Niagara Falls, Ont.—Hydro-Electric Power Commission of Ontario awarded contract for construction of intake and ship channel in connection with the Chippawa-Queenston power development to Tomlinson, Macaw & Macdonald, of Winnipeg. The price is in the neighborhood of half a million dollars. There were 12 tenders submitted.

Ottawa, Ont.—Tenders will be received by the Ottawa Hydro-Electric Commission until 12 o'clock noon, May 12, on the following material: Approximately 46,354 ft. of fibre conduit, 7,400 lbs. of "T" beams and 27,310 lbs. of cast iron manhole covers. Specifications may be seen at the Construction office of the Commission, 75 Laurier Ave. West.

St. John, N.B.—Contract for erection of a transmission line for the distributing of power to the city has been let by N. B. Hydro Commission to the Canadian Bridge Co., Ltd., Walkerville, Ont., who will build the foundations for the towers, fabricate and erect the towers and stretch the cables. The location survey of the proposed line to Moncton has been completed. A test for rock bottom has been commenced at Sherwood Lake, West Branch of the Musquash, preparatory to the construction of an important storage dam in that area.

Vancouver, B.C.—A proposal to construct and operate a central steam heating plant capable of supplying steam heat and power to buildings in this city has been received by the city clerk from the contracting firm of Adkinson and Dill. Permission to lay conducting mains through the city on the same basis as granted similar concerns in Portland and Tacoma is also asked by this firm. The matter will be brought before the City Council.

Winnipeg, Man.—Contract for construction of an addition to the McPhillips St. sub-station of the Hydro-Electric system awarded by City Council to Foster & Henson, at \$6,859.

RAILWAYS

Earnestown, Ont.—Grand Trunk Railway plans to have new steel laid in this vicinity.

Hamilton, Ont.—Plans for the Ottawa St. incline railway provide for a feeder line—a single-track trolley line from King St. to the foot of the incline railway. Application for a charter is now before the bills committee of the Legislature.

London, Ont.—Approximately 400 extra men will be employed in the London division of the Grand Trunk Railway this summer laying new steel rail and rebalasting the right-of-way. New steel rail is to be laid in the vicinity of Merriton and also between Hyde Park and Sarnia.

Oakville, Ont.—Town Council decided to install an auxiliary gasoline engine pumping plant of 150 h.p. Estimated cost, \$32,000. Clerk, Percy A. Bath.

Quebec, Que.—A. E. Robert, president of the Quebec Railway, Light & Power Co. announced that a number of extensions of the system to points in the vicinity of Quebec will be completed in the course of the next few years.

FACTORIES AND LARGE BUILDINGS

Birch Cliff, Ont.—Ratepayers authorized the school trustees to construct four additional class rooms to the present school in S. S. No. 15, at a cost of \$40,000.

Brockville, Ont.—J. Areno, of Smith's Falls, plans erection of business block on Beckwith St.

Brockville, Ont.—Plans are being prepared here for the construction of a consolidated eight-room school at Mountain, Dundas county.

Calgary, Alta.—Work will proceed at once on erection of new church building for Central Christian Church.

Calgary, Alta.—Tenders closed April 23 for alterations and additions to the General Hospital, Bridgeland. City Clerk, J. M. Miller.

Chapleau Tp., Ont.—Township Council passed a by-law providing for the raising of \$75,000 for the purchase of a site, the erection of a school and purchase of equipment. Clerk, T. R. Serre, Chapleau.

Chatham, Ont.—Pennington and Boyd are architects for the new Blessed Sacrament Church which will cost about \$65,000. Tenders have been called.

Cranbrook, Ont.—Board of Education will either erect a new 8-room school or an addition to the Central School. Ratepayers authorized \$60,000 for the work.

Delhi, Ont.—Ratepayers passed by-law to borrow \$15,000 for construction of a two-room continuation school. Clerk, James A. Lawson.

Drumheller, Alta.—Fire destroyed the power plant of the Drumheller Land Co. and the power plant and tippie of the Callie Mine. Loss, \$125,000.

Drummondville, Que.—Contract for structural steel for \$500,000 factory for Dominion Silk Dyeing & Finishing Co., Ltd., and for structural steel for large warehouse for Butterfly Hosiery Co., Ltd., awarded to the Walsh Plate & Structural Works, Ltd., Drummondville.

Fort William, Ont.—Contract for erection of four-roomed brick addition to the Ogden St. school was awarded by the Board of Education to Russell Bros., at \$24,969. Other tenders received were: Klomp & Hardy, \$24,980; Russell & McMahon, \$25,156; Cox & Wilcox, \$25,984.

Fredericton, N.B.—Contract for removing and repairing a building at the York County Municipal Home awarded to Leander White, of South Devon, N.B.

Fredericton, N.B.—A lumber manufacturing plant at Bantalour station, 16 miles south of McGivney Junction on the Transcontinental division of the C. N. R. was destroyed by fire with a loss of approximately \$25,000. The mill was owned by Harold M. Young, of this city.

Galt, Ont.—Ray Hall, Architect, will prepare plans for erection of plant for the International Tank & Silo Co.

Guelph, Ont.—The Granite Cement Block Co. of Port Colborne have removed to this city and will erect a new building.

Hamilton, Ont.—Wentworth County Council may erect High School.

Hamilton, Ont.—Tenders for new Labor Temple were received by John Pryke, 487 Concession St., Mount Hamilton, Secretary of the Hamilton Labor Temple Association, until May 1.

Hamilton, Ont.—Contract for electrical supplies and telephones at the Dunsmore School awarded to Cutley & Breay, at \$10,097, and for plumbing and heating to the Adam Clark Co., for \$71,871.

Harrison, Ont.—Ratepayers decided to recommend the submission of a bylaw authorizing a loan of \$25,000 to a new industry. Clerk, H. J. Hucks.

Kenora, Ont.—Preliminary work has been started by Silverman Bros. on the rebuilding of the former Vereker block.

Lachine, Que.—Contract for erection of building to be used as power plant awarded to Fournier & Freres, Ltd., for \$13,910. Following tenders were also received: Quinlan, Robertson & Genest, Ltd., \$16,700; Newton-Dakin Construction Co., Ltd., \$16,750; H. J. Norton, \$19,260; Josephat Theoret, \$18,175; and F. C. Brunet, \$19,700.

Leamington, Ont.—Contract for erection of St. Michael's Church awarded to B. Bondy, of Chatham.

Leamington, Ont.—High School Board applied to Town Council for \$40,000 for erection of a four-room addition to the school.

Lindsay, Ont.—Municipal Council passed by-laws providing for the raising of \$3,500 and \$1,500 respectively for the enlargement of the Collegiate Institute site and the enlargement of the site of the Central School. Town Clerk, W. R. Alley.

London, Ont.—London Methodist Council has decided to erect a church in Ealing district this summer.

London, Ont.—Members of St. Paul's Cathedral plan erection of new rectory and will remodel present one for institutional building.

Moncton, N.B.—School Board proposes to erect a school in east end of city. Secretary, A. O'Blenes.

Moncton, N.B.—New Baptist Church building will be erected at corner of Highfield and St. George Streets by day labor under supervision of Duncan Jonah. Brick construction. Estimated cost, \$75,000.

Montreal, Que.—Plans for the proposed ten-storey hotel have been prepared by D. J. Spence, architect of this city.

Montreal, Que.—MacVicar & Heriot, architects, are preparing plans for erection of new Fairmount Presbyterian Church, Masson St.

Montreal, Que.—Contract for structural steel for new store at 699 St. Denis St. awarded to the Walsh Plate and Structural Works Ltd., of Drummondville, Que.

Montreal, Que.—Fire destroyed the premises of the J Cowan Chemical Co., Ltd., and the Montreal Cotton Wool Waste Co., Ltd., 173-181 Common St. Loss, \$100,000.

Montreal, Que.—Construction work will start in June on the proposed new theological seminary for the Catholic Society of Foreign Missions of the Province of Quebec.

Monteith, Ont.—Plans are under way to erect a larger building for the Northern Academy here, at an estimated cost of \$100,000. Address Dr. J. B. McDougall, of North Bay.

Montreal, Que.—Permit has been issued for the construction of a convent at the corner of Mount Royal Ave. and Cartier St., to cost \$172,000, and another building at the corner of Notre Dame and Joliette Streets, to cost \$62,000.

Montreal, Que.—The construction of a ten-storey hotel in the vicinity of Windsor Station is under consideration and will likely take definite form within a short time. Plans have been prepared for such a building, comprising a main building and two wings, the cost of which would be around five million dollars. A company will be formed to finance the project.

Nepcan Tp., Ont.—Tenders will shortly be called for the proposed High School, estimated cost \$50,000.

Niagara Falls, Ont.—Two large concrete buildings are being erected by the Monarch Engineering Co., Lewis Ave. Estimated cost, \$152,000.

Niagara Falls, Ont.—Contract for sub-station let by local Hydro Commission to the Robertson Construction Co., at \$67,190. Other tenders were: Canadian Engineering Co., \$67,100; R. Smith & Sons, \$78,406; R. Bennett, \$78,975.

Niagara Falls, Ont.—Work on the construction of the new booster pump house at Falls View will be carried on by day labor under the supervision of the superintendent of the Waterworks Commission. Contract for the electrical work was let to Smith & Hughson.

Normandin, Que.—Erection of two schools is projected.

Ottawa, Ont.—Reeve Fred Bell, J. E. Caldwell and Henry Washington, representing Carleton County Council submitted plans to the City Council for an addition to the Court House.

Petite Cote, Ont.—Contract for erection of Sacred Heart Church awarded to Benjamin Bondy, of Chatham, and the plumbing and heating to C. E. Greenan, of Windsor. Estimated total cost, \$100,000.

Port Credit, Ont.—Plans for the proposed social centre building and Sunday School of the Port Credit Methodist Church are being prepared by W. G. Burns, local architect. Estimated cost, \$22,000.

Preston, Ont.—Bulk and separate tenders will be received by John Cowie, Secretary, Preston Public School Board, until 4 p.m., Monday, May 8, for the erection of a school building on Moore St. Plans and specifications may be seen at the office of the Secretary and at the office of F. W. Warre, Architect, Home Bank Bldg., Hamilton.

Regina, Sask.—Western Development Co., Ltd., will erect a business block this summer on the corner of Hamilton and Davin Streets, at cost of \$80,000. Contract has been awarded to the Poole Construction Co.

St. Anne de Beaupre, Que.—The temporary chapel to be erected is estimated to cost \$20,000. A Juvenile is also being erected at a cost of \$10,000.

St. Catharines, Ont.—Members of Westminster Presbyterian Church plan erection of new church on Queenston St. Pastor, Rev. A. W. Thomson.

St. Catharines, Ont.—Board of Education let contract to the W. H. Yates Construction Co., of Hamilton, Ont., at \$420,977, for the new Collegiate Institute and Vocational School. Following tenders were also received: All trades—A. B. Robertson, Niagara Falls, \$563,491; Page & Co., Toronto, \$487,000; Norman McLeod, Toronto, \$489,000; S. E. Dinsmore Co., Ltd., Windsor, \$493,607; Newman Bros., Ltd., St. Catharines, \$515,000; Witchall & Son, Toronto, \$486,389; Witchall & Son (except mechanical trades), \$403,709; P. H. Secord & Son, Brantford (not including plumbing, heating, ventilating and electric wiring), \$365,000; Carswell Construction Co., Toronto, \$480,000; Dickie Construction Co., Toronto, \$497,784; Anglin-Norcross, Ltd., Toronto, \$477,800. Electrical work—Beattie McIntyre Ltd., Toronto, \$9,350; Ramsden & Roxborough, Toronto, \$8,500. Plumbing, heating, ventilating and electric wiring, P. H. Secord & Son, Brantford, \$77,000 and \$1,500; plumbing, heating and ventilating, Purdy Mansell Ltd., Toronto, \$69,500; heating and ventilating, John Peart, St. Catharines, \$60,439; heating, ventilating, temperature control and pipe covering, E. Cardwell, Welland, \$62,000; plumbing, S. P. Goulay, St. Catharines, \$21,485; plumbing, heating and ventilating, W. J. McGuire, Toronto, \$75,500; miscellaneous iron work, Canada Wire & Iron Goods Co., Hamilton, \$9,939; ornamental iron, Shipway Iron, Bell & Wire Co., Toronto, \$12,110; plumbing, heating and ventilating, W. G. Edge, Ltd., Toronto, \$69,400.

St. John, N.B.—John Flood & Sons have been awarded contract for building new school in Holy Trinity Parish. The tenders submitted were: George Lawson, \$84,850; J. Corbett, \$82,273; H. O. Clarke, \$78,000; Munro, \$76,400, plus \$2,800 for stone corners; B. Monney & Sons, \$77,735; J. A. Grant & Co., \$76,000; John Flood & Sons, \$73,000.

St. Thomas, Ont.—A campaign will be launched on May 2 to raise \$35,000 for improvements and extensions at Alma College. Chairman of Committee, Walter F. L. Edwards.

Sarnia, Ont.—Following a recent meeting of directors of the Dominion Alloy Steel Corporation, it was announced that some changes in the plans of the company have been made, and the plant to be erected will cost \$5,000,000 instead of \$3,000,000.

Scarboro Tp., Ont.—Bulk and separate tenders will be received by W. D. Annis, Secretary, School Board, until 5 p.m., Monday, May 8, for the erection of a High School building at the junction of St. Clair Ave. and Kingston Road. Plans and specifications may be obtained at the office of Burden, Gouinlock & Carter, Associated Architects, 101 King St. West, Toronto, or seen at the office of the Secretary, Council Chambers, Birchcliff, Ont.

Smith's Falls, Ont.—International Button Co. plans erection of new factory and purchase of machinery.

Sudbury, Ont.—Permit issued for two-storey brick La-berge Block on Louis St. cost \$22,000. Application has also been made for a two-storey brick block to be known as the Davis block on Borgia St.

Sudbury, Ont.—Permit issued for four-roomed Separate School building on Shaughnessy St. It will be a two-storey brick building. A. Bernier has the brick contract and L. Lacosse the frame work contract. Estimated cost \$33,000.

Swan River, Man.—Fire destroyed the Agnew and Taylor blocks, causing a total loss of \$40,000.

Toronto, Ont.—A site has been chosen for the erection of new Machinery Hall at Exhibition grounds. Estimated cost, \$300,000.

Toronto, Ont.—Nos. 91 and 96 Bay St., owned by Sir Henry Pellatt, are to be demolished and a large office building erected in their place.

Toronto, Ont.—A campaign to raise \$10,000 for the enlargement of the Sunday School building has been launched by the Parish of St. Edmund's, Davenport and Dovercourt Roads.

Toronto, Ont.—New Sunday School building will be erected this summer in connection with Parkdale Methodist Church. Pastor, Rev. A. T. Addison. Estimated total cost, \$51,000.

Toronto, Ont.—Members of the First Canadian Church, 693 Bathurst St., plan erection of church building on the corner of Ossington and Burnfield Avenues. Pastor, Rev. C. J. Felton.

Toronto, Ont.—Parish Hall of St. Matthew's Church is to be enlarged at a cost of \$10,000. The heating system will be renovated at cost of \$7,000. Rector, Rev. W. E. MacKay.

Toronto, Ont.—The governors of Havergal College have decided to erect a new building on St. Clair Ave., midway between Yonge St. and Avenue road. Excavation will be begun either next fall or in the spring.

Toronto, Ont.—Second reading was given to a bill by the Provincial Legislature to permit Upper Canada College to make a loan of \$100,000 to build an addition to the Preparatory School and a science wing to the main building.

Toronto, Ont.—Parks Committee acquiesced in the application of Dr. Hastings, M.O.H., for permission to erect the new Home for Nurses in connection with the Isolation Hospital on a site in Riverdale Park, near the existing hospital buildings.

Toronto, Ont.—Toronto Transportation Commission plans to erect buildings on the site of the old Hillcrest race track at a cost of approximately \$1,000,000. Over and above this expenditure will be the cost of track and layout and the erection of a stores building.

Toronto, Ont.—Separate or bulk tenders for the erection of a fire hall on Commissioner St. will be received until 12 o'clock noon, Tuesday, May 9, addressed to C. A. Maguire (Mayor) Chairman, Board of Control. Plans and specifications may be seen at the office of the City Architect.

Toronto, Ont.—Board of Education awarded following contracts: Givins St. School—masonry, Jas. W. Hewitt, \$6,600; structural steel, Hepburn & Disber, \$620; carpenter work, R. Campbell, \$6,750; roofing, E. Lankin & Son, \$797; plastering, R. C. Dancy, \$1,300; painting, Jas. Casey, \$786; plumbing and heating, W. G. Edge Co., \$2,198; electric wiring, Toronto Electric Co., \$475; local phones Bates & McPherson, \$90; asphalt mastic, Carmichael Waterproofing Co., \$286. Parkdale School—Masonry, H. Lucas & Son, \$18,840; structural steel, Hepburn & Disber, \$1,380; carpenter work, R. Campbell, \$9,200; ornamental iron, Ornamental Iron Products Ltd., \$569; roofing, E. Lankin & Son, \$759; plastering, A. D. Grant, \$2,200; painting, F. Booth & Son, \$1,057; plumbing, Sheppard & Abbott, \$1,026; heating, Sheppard & Abbott, \$3,068; electric wiring, Toronto Electric, \$635; asphalt mastic, Carmichael Waterproofing Co., \$157. Rose Ave. School—Plastering, R. C. Dancy, \$7,664; ornamental iron, Ornamental Iron Products, Ltd., \$2,444; painting, Phinnemore Painting Co., \$3,980; local telephones, Bates & McPherson, \$500. North Toronto High School—Plastering, R. C. Dancy, \$7,600; asphalt mastic, W. A. Moffatt, \$680; painting, James Casey, \$3,300; terrazzo floors, Italian Mosaic & Marble Co., \$3,959.

Valleyfield, Que.—Structural steel contract for new theatre awarded to the Walsh Plate & Structural Works, Ltd., of Drummondville, Que.

Welland, Ont.—City Council will likely secure plans shortly for the proposed new library building. City Clerk, W. E. Forster.

Welland, Ont.—The enlargement of the Welland County General Hospital is projected. Chairman, W. J. Healey. Estimated cost, \$60,000.

Welland, Ont.—The St. Thomas Packing Co. has purchased a site at the corner of Division St. and Helme

Ave. for the erection of its proposed new cold storage plant.

Welland, Ont.—Lackawanna Steel Tubes Ltd., a recently incorporated concern, has taken over the Welland Machine & Foundries Ltd. A new mill building will be erected 80 ft. by 400 ft. The company will manufacture seamless steel tubes.

Willowdale, Ont.—Ratepayers decided to purchase a site at Lansing for erection of four-room school.

Windsor, Ont.—Local branch of the Navy League of Canada plans erection of a shore station and clubhouse at a cost of \$5,000.

Winnipeg, Man.—Plans are being prepared by Jordan & Oliver, architects, for the construction of a one-storey office building at the corner of Garry St. and Ellice Ave. for Stevenson, Feilde & Crable. Estimated cost, \$20,000.

Winnipeg, Man.—Tenders will be received at the office of the Winnipeg Public School Board until 5 p.m., Thursday, May 4, for the erection of a stone and brick 14-room school on site between Flora and Stella Streets, Sec.-Treas., R. H. Smith.

MISCELLANEOUS

Bosanquet Tp., Ont.—Township Council plans drainage work at estimated cost of \$70,000. Clerk, Geo. Sutherland, Thedford, Ont.

Calgary, Alta.—Tenders, addressed to the City Commissioners, will be received at the office of J. M. Miller, City Clerk, until 5 p.m., Wednesday, May 10, for a 2-2½-ton chassis, with power-driven capstan winch, 2,000-lb. pull, all in accordance with specifications obtainable from Mr. Mackay, Superintendent, Electric Light Department, City Hall.

Lethbridge, Alta.—Tenders for furnishing 13 cast iron gates will be received until 2 p.m., May 16, by the Irrigation Council, Lethbridge. (See official adv.).

London, Ont.—The London Bridge Co., a subsidiary company of the Structural Steel Co., of Welland, has been organized with a capital stock of \$100,000. Three acres of land have been purchased in East London, and a plant will be equipped as soon as possible.

Montreal, Que.—Provincial charter has been granted to Crushed Stone & Construction, Ltd., capitalized at \$49,000. C. Alfred Sylvestre is a director.

Petrolia, Ont.—Dominion charter has been granted to McMurray Asphaltum & Oil, Ltd., capitalized at \$100,000. Thos. Draper is one of the directors.

St. Adele, Que.—Contract for new steel penstock for Rolland Paper Co., Ltd., awarded to the Welsh Plate & Structural Works, Ltd., of Drummondville, Que.

Toronto, Ont.—City Council passed by-laws authorizing the issue of debentures totalling \$1,589,000. The money is required for the following works: New bridge over the Don at Gerrard Street, \$762,000; purchase of land for Boulevard Drive between Dowling Ave. and Dufferin St., \$210,000; harbor improvements at Sunnyside, \$411,000; site for new Observation Home, \$25,000; Nurses' Home, in connection with the Isolation Hospital, \$100,000.

Welland, Ont.—Tenders will be received by C. L. Coulson, City Engineer, until 4 p.m., Thursday, May 4, for all work and material required for the construction of piers and lattice fences at the entrance to Chippewa Park.

Welland, Ont.—Hydro-Electric Power Commission of Ontario let contract for dredging on the Welland River and earth section of the canal, in connection with the Queens-County-Chippewa power development, to Lachay & Co., the contract amounting to between \$100,000 and \$500,000.

Winnipeg, Man.—Contract for 40 manhole covers awarded to Western Prairie Foundry Co., Portage la Prairie, at \$25 a set.

Woodstock, Ont.—Drains for Maud and Dufferin Streets are contemplated. Clerk, James C. Haight.

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Activated Sludge Plant at Brampton, Ontario

Sedimentation Tanks Reconstructed for New System — Capacity 300,000 Gal. per Day — Four-Hour Aeration Period — Diffusion Ratio 4.8 — Sludge Dewatered in Tank — Used as Fertilizer — Troubles Overcome

By W. M. TREADGOLD

Associate Professor of Surveying, University of Toronto.

Engineer, Town of Brampton

CONSTRUCTION of a sewerage system for the town of Brampton was commenced in 1907 and the system put into operation in the fall of 1908. Owing to the fact that the town proper was located on low ground, with the Etobicoke River running through, it was an easy matter to provide for storm drainage and so it was considered advisable to use the separate system for sanitary sewers. The main drain was a 15 in. vitrified pipe on a 0.25% grade with branches which served the north-east and west sections of the town, and later, in 1916, a second 15 in. main was constructed to serve the south and south-west sections. There are over 10 miles of

and stability of the effluent, and on account of the comparatively small volume of sewage to be treated, no trouble was anticipated from the disposal of the sludge.

Activated Sludge Plant Recommended

Accordingly, an activated sludge plant was recommended which involved the reconstruction of one side of the sedimentation tanks for use as an aeration tank, the construction of a settlement tank, compressor house and open sludge beds. Neither the cost of construction nor the cost of operation promised to be much higher than for any other method of treatment, and, on account of the

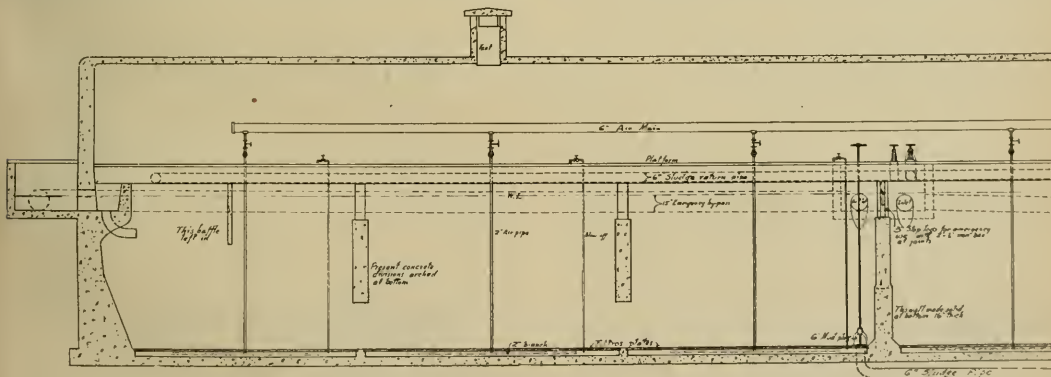


FIG. 1—LONGITUDINAL SECTION OF PART OF ACTIVATING TANK

streets sewered at the present time, which represents about 60% of the total mileage of streets in the town and the amount expended to date is about \$150,000, including the disposal plant and site. Sedimentation tanks were designed to take care of the disposal. These, although cleaned out periodically, very soon gave rise to complaints and the water in the stream became badly contaminated and injunctions were threatened.

Finally the town authorities decided to ask the engineer for a report on a system of sewage purification that would alleviate the nuisance and be satisfactory to the Provincial Board of Health. In the operation of the sedimentation tanks, there was only a difference in elevation of 5 ft. 6 in. between the inlet and low water level of the stream, so that it would have been necessary in constructing sprinkling filters to use a low lift pump, as there would not have been enough head to ensure proper operation. Favorable reports had been made of the success of the activated sludge method of treatment and it has proved that excellent results could be obtained in the character

fertilizing value of the sludge it would easily be disposed of. At the present time, the Dale estate, owning the largest conservatories in the country, are taking all the sludge from the plant and pay for the cost of handling it from the beds to the conservatories. They had previously tried out the sludge from the sedimentation tanks which proved unsatisfactory. The results obtained in experimenting with the activated sludge were very gratifying. Their experiments have not been so much of a technical character as of a practical nature and the usefulness of the sludge has been quite marked in the cultivation of their famous American Beauty roses. The best results seemed to have been obtained in the second season after the soil has been treated with the sludge which has been dried and finely powdered.

Tenders for the work were called in the fall of 1918 and the contract awarded to G. G. Reid. A description of the plant itself may be divided under four heads.

One of the pair of sedimentation tanks is shown in partial longitudinal section and cross-section in Figs. 1 and

2 respectively. It is divided into six compartments by cross walls and was reconstructed by deepening 4 ft., and by building a sloping side wall at an angle of 45 deg. with arched openings in each of the cross walls with the exception of the centre one. This sloping wall gave the sewage

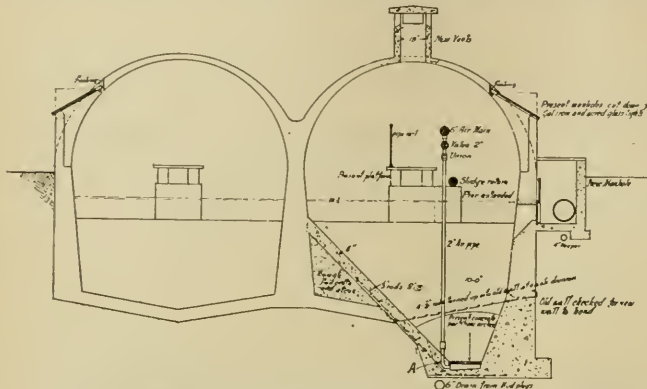


FIG. 2—CROSS-SECTION THROUGH PRESENT TANKS — HATCHED PORTION SHOWS RECONSTRUCTION

and sludge a revolving motion at right angles to the direction of flow and kept the activated sludge well mixed with the raw sewage. The superficial area of the tank was 1325 sq. ft. and the cross sectional area 84 sq. ft. Its capacity is 52,500 Imperial gals., which at the maximum rate of 300,000 gals. per day means that it would give about a 4-hour aeration period. The centre cross wall was carried straight down so as to divide the chamber into two parts each part being complete and capable of being used with proper pipe drains and valves so as to be independent of the other section in case repairs has to be made to the filtros plates or air lines. Three rows of filtros plates supplied by the General Filtration Co., of Rochester, N.Y., each plate 12 by 12 by $1\frac{1}{2}$ in. giving a plate area of 275 sq. ft., or a diffusion ratio of 4.8 which is rather smaller than in some plants in operation. No trouble has yet been experienced with these plates, through breakage or clogging. A 5 in. air line with a 2 in. connection to the under side of the filtros plates. Blow-off connections are made to take care of any water accumulating under the plates. Ventilators and windows were provided and at any time during operation there is no disagreeable odor or smell. Sufficient sludge is returned to keep the amount of sludge in the aeration tank at about 25%.

Settling Tank

At the end of the aeration chamber a settling tank shown in Figs. 3 and 4, was constructed 16 by 30 ft. inside and 22 ft. below water level. It is divided into two chambers each with a hopper bottom 4 by 4 ft. Two channels, one for each compartment, lead from the aeration chamber. A 3 by 10 in. cypress baffle board forces the flow to the bottom of the tank and the effluent runs over collecting weirs which lead to channels that connect with the 15 in. drain pipe to the river. The two chambers are about three quarters the size of the aeration chamber. A 6 in. sludge pipe runs down to within one foot of the bottom of each chamber and has a $\frac{3}{4}$ in. air pipe down far enough to discharge the sludge up through this pipe by compressed air either out to the sludge beds or back to the sludge return pipe which empties into the aeration chambers.

Compressor House

The building for the compressor and motor is directly over the settling tank. At present, the plant is operated by a No. 4 Nash Hytor compressor direct-connected to a 30 h.p. Westinghouse motor, 3-phase, 25-cycle, 550-volt, at 480 r.p.m. The compressor runs at an actual working

pressure of about 5 lbs. and delivers about 450 cu. ft. of air per minute, which in the daytime means about 2.1 cu. ft. of air per gallon of sewage. This is somewhat in excess of the amount of air used in some other plants. It is the intention to instal a second unit of smaller capacity in the near future which could be used at night when the amount of sewage is considerably less than the amount treated during the daytime. The air delivered by this machine has an advantage over that furnished by other types of compressors where it is to be diffused by perforated plates, in that the compressor washes the air as it is being compressed and so cleanses it that there is less chance of the plates becoming clogged with dirt or grease.

Sludge Bed

Two open sludge beds were excavated each about 20 by 80 ft. and varying in depth from 3 ft. at one end to 5 ft. at the lower end. At first the sludge was run directly into these. There it was allowed to dry and then thrown out on the bank and carted away. This drying out process was slow. Last year the beds were filled during the summer and fall and in the winter the sludge would freeze and could be conveniently removed. With a view to dewatering, to some extent, a small concrete tank 8 by 10 by 3 ft. deep was constructed which was sufficient to take care of the sludge discharged every second day. The sludge was emptied into this and allowed to settle for 6 or 7 hours. Then the water was drawn off amounting to from 40 to 50% of the content and turned back into the tanks the remaining sludge being then run off into the sludge bed. This result-

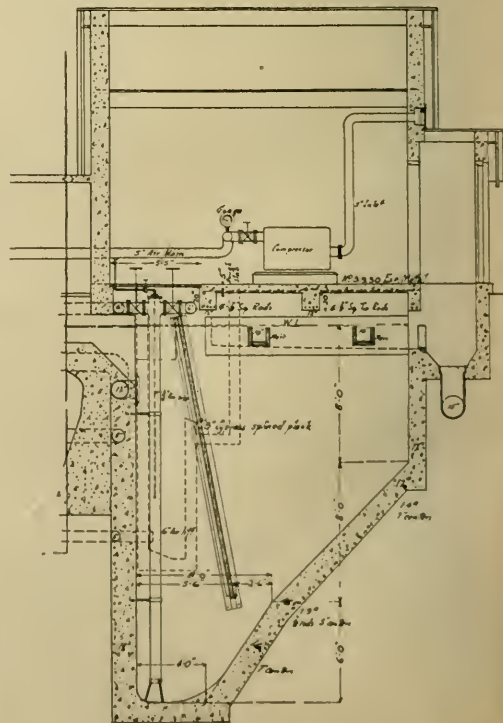


FIG. 3—CROSS-SECTION OF SETTLING TANK

ed in a saving in the amount of sludge turned into the drying beds and it was found that only an average of 2 cu. yds. per day reached these beds.

The plant has now been running since April, 1919, and has proved very satisfactory. The compressor runs at intervals—continuously from 7 p.m. to 8 a.m., and from 11 a.m., to 4 p.m., or 18 hours per day. It has been found that no serious change in the effluent occurs during this three hour interval and there is a saving in the cost of power as the periods when the compressor is not working are the periods when the peak load comes. Up to the present a man has been kept in attendance during the day who has taken a great interest in the operation of the plant and who has been kept there to deal with some of the troubles of operation which are always present in a new system, especially one that has been the result of changing from the original design to one that the plant was never intended for. It has added to the cost of operation but it was considered advisable to get good operation before cutting down on the attendance. It might be worth while to consider some of the troubles that developed and which have been remedied.

Variable Effluent

The effluent at one time would run clear and stable and not long after, for no apparent reason, the fine sludge in the settling tank would rise up and overflow the weir and run out to the stream with the effluent and pollute the stream. That was accounted for partly by regulating the discharge of the sludge pipe. If this were too great it would stir up the settled sludge too much and the sludge would rise up and overflow into the outlet. Also it was found that refuse and grit would block up one of the channels leading from the aeration chamber to the settling tank and thus all the flow would be through one section of the settling tank. The grit and seeds would settle in this channel, because the rate of flow was small. This channel is now cleaned regularly and the trouble has disappeared. Again, there have been stoppages of power at night and the plant would not be in operation. This is being remedied by installing an automatic cut in so that when the power comes on again the motor will start up.

In a separate system some storm water is bound to get into the mains either through roof water being connected up to the drains or through privileges that have been previously granted to manufacturing firms to take care of storm drainage, and it is found that whenever a heavy rain occurs the sudden inflow of water will tend to carry away the activated sludge in the tank and there will not be sufficient left to ensure good action with the incoming sewage and it will take some time to build up the sludge to standard efficiency. It now arranged to by pass this heavy flow when it becomes greater than the plant can accommodate through the tanks.

During the first year a deposit of lime formed on the rotor of the compressor and the machine had to be taken down. The water used for circulation was very hard. A recirculating system using soft water was installed which worked satisfactorily but last summer the water delivered through the mains was much softer and this extra equipment was not necessary. The compressor when operating made considerable noise which would have been serious had the plant been near any residences. This noise has been reduced very much by running the inlet pipe out through the wall and reducing the 5 in. pipe with a reducing coupling in which a 2½ in. nipple 6 in. long is joined.

The plant is now treating about 250,000 gals. per day and about 2 cu. yds. of sludge reaches the drying bed every day. The original cost of the sedimentation tanks

was \$8,000 and the total cost of converting to the activated sludge process was \$17,000. The power consumption runs at an average of \$1.50 per day. The attendant receives \$3.00 per day. The effluent obtained is stable, colorless and odorless. Frequent tests are made for stability by

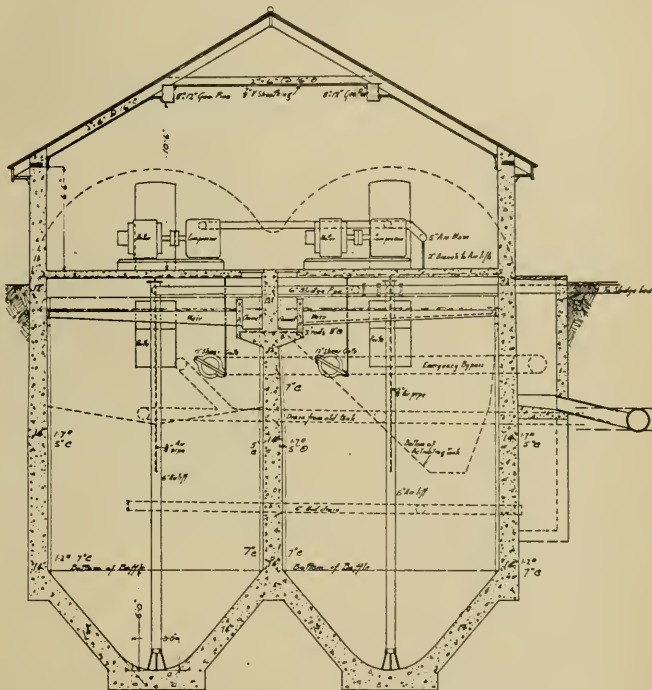


FIG. 4—LONGITUDINAL SECTION OF SETTLING TANK

means of methylene blue solution. The stream into which the effluent discharges has changed remarkably and runs clear. There has not been any further complaint from any of the property owners abutting on the stream below the outlet.

INCREASE IN ASPHALT PAVEMENT YARDAGE

AMERICAN cities are making tremendous strides in street paving said Joseph R. Draney, president of the Asphalt Association at a meeting of the Association in New York recently. Reports from city engineers show that over 30,000,000 sq. yds. of asphalt equivalent to 1,750 miles of pavement 30 ft. wide, were laid on city streets last year. Twenty-three million square yards were laid on state highways and the area laid on county and district roads brought the total for 1921 up to 68,000,000 sq. yds., enough to build two roads, each eighteen feet wide, the one extending from Augusta, Me., to San Francisco, Cal., and the other from Augusta, to New Orleans. Despite the industrial depression that existed throughout the year, 1921, was the greatest year in the history of the asphalt business.

Lackawanna Tubes, Ltd., has taken out a Federal charter, with an authorized capitalization of \$525,000. This organization has taken over the plant and equipment of Welland Machine and Foundries, Ltd. The principal product will be boiler tubes. This is understood to be the first firm to produce seamless steel tubes in Canada. Imports of such products from the United States have been a sizable item.

Beach Water Works Pumping Plant at Hamilton

General Description of Machinery, With Special Reference to Recent Installation of Two Ten-Million-Gallon Pumping Units — Tests Show Efficiencies as High as 80 Percent — Historical Review of Earlier Equipment

By R. DE BRUNO-AUSTIN

Managing-Director, Turbine Equipment Co., Ltd., Toronto

ONE of the most interesting features of the Beach Pumping Station, which supplies water to the city of Hamilton, is that the pumping machinery installed there contains examples of the earliest and most modern types. The former consists of two vertical beam type compound condensing engines direct connected to plunger pumps, and were installed in 1859. They operate condensing, the vacuum carried being 24 in., referred to a 30 in. barometer. The jet condensers, as well as the air pumps, are submerged in a tank of water. This tank is kept full by using cold water pumps, taking supply from the suction pipe of the main pumps. The air pumps obtain their supply from these tanks, through jet condensers, and discharge into a cast-iron box which is connected to the sewer. The exhaust from the low-pressure cylinders discharges into the condensers.

The high-pressure cylinders are 20 in. bore by 6 ft. stroke, and the low-pressure 40 in. bore by 8 ft. stroke. Each engine has a fly wheel 24 ft. in diameter, weighing 24 tons. The capacity of each unit is 1,800 Imperial gals. a minute. The height from the foundations is 51 ft., extending through three floors. The dimensions of the foundations are 51 by 24 ft.

These engines were built by the John Gartshore Co., Dundas, Ont., and were originally designed to work against a pressure of 80 lbs. per sq. in., steam being supplied to the cylinders at a pressure of 30 lb.

The capacity of each pump was originally 38½ gals. a stroke, or 77 gals. for each revolution of the crank shaft. In 1882, they were enlarged to give a capacity of 60 gals. a stroke, or 120 gals. a revolution. The steam ends, however, were not altered, although a new battery of boilers, consisting of two 78 in. by 16 ft. horizontal return tubular, was purchased, which enabled the steam pressure to be increased to 60 lbs. per sq. inch. In 1892 it was decided to increase the steam pressure to 70 lb.

In 1887 and 1888 two cross-compound horizontal condensing engines, connected to plunger pumps, were purchased,

each having a capacity of 4,250,000 Imp. gals. a day. The high pressure cylinders are 22 in. diameter by 36 in. stroke, and the low pressure cylinders are 44 in. diameter by 36 in. stroke. The dimensions of the foundations are 56 ft. long by 46 in. wide.

The valves on the steam end are of the slide valve type. The pump valves are of the Corliss type, and there are 560 in each valve chamber. The 13½ in. diameter plungers are hollow cast iron, or what is known as the floating plunger. These plungers work in bronze sleeves bolted in the centre of the pump chamber or cylinder. The rods carrying these plungers are outside packed. Jet condensers are used and the vacuum carried is also 24 in., referred to a 30 in. barometer. This machinery was built by the Osborne-Kelley Manufacturing Co., of Hamilton.

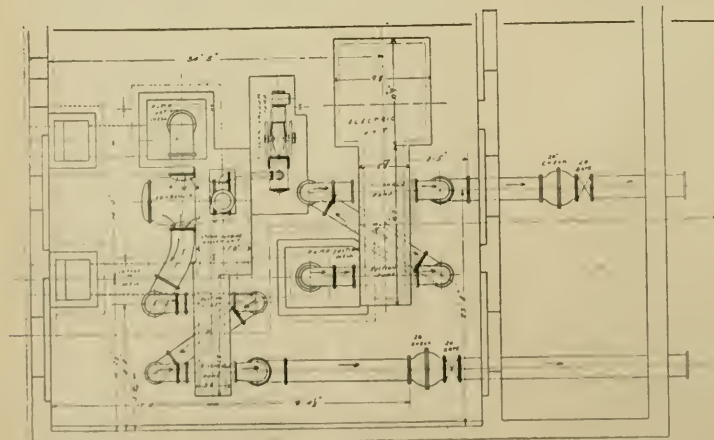
A battery of five 54 in. by 14 ft. horizontal return tubular boilers was purchased at the same time as the above-described pumps. During the test they developed a duty of 114,000,000 ft. lb. per 1000 lb. of steam.

In 1910 the city decided to use electrical power for pumping their water supply, and to retain the steam-driven pumps as an auxiliary to be used during interruptions to the electrical power. Therefore tenders were called for synchronous-motor-driven centrifugal pumps. The John McDougall Co., Montreal, Que., were awarded the contract for two 16 in. 2-stage turbine pumps, direct-connected to 630 h.p. Canadian Westinghouse synchronous motors, operating at a speed of 750 r.p.m. The capacity of each pump was to be 6½ million Imp. gal. a day against a total head of 300 ft. At that time the John McDougall Co. was the only concern in Canada building pumps of this type. Their chief engineer was W. C. Browne, who was formerly with the Worthington Pump Co., of New York.

These pumps have what is known as the Jaeger (Leipzig, Germany) method of hydraulic balance against end thrust. This system of individual impeller balancing is not proof against end thrust, however, and substantial marine type of thrust bearings are furnished to augment

it. They were first tested in January, 1911, but did not meet the builders' guarantees either for capacity or efficiency. Larger impellers and diffusion vanes were then installed, and in June, 1912, James Bain, the chief mechanical and electrical engineer of the city of Hamilton, and an engineer representing the builders, made another test which was quite satisfactory. The pump efficiency guaranteed was 72%, and that obtained after the changes to impellers and diffusers was 72.74% on No. 1 unit and 77% on No. 2 unit. The latter was considered at that time an extremely good result.

In the summer of 1912 it was decided to increase the electric pumping capacity, and a contract was awarded to the Canada Foundry Co., of Toronto, for two 16-in. 2-stage turbine pumps of Mather & Platt design. The capacity of each was to be 6½ million Imp. gal. a day against



PLAN OF DE LAVAL TURBINE AND MOTOR-DRIVEN PUMPS SHOWING CONDENSER AND PIPING ARRANGEMENT

285 ft. total head, and they were to be direct connected to 650 h.p. Canadian General Electric 3-phase, 25-cycle, 2,200 volt, 750-r.p.m. synchronous motors. The city's specifications contained a clause that no efficiency under 80% would be considered, and despite the fact that many European pump builders submitted tenders, the Canada Foundry Co.



TEN-MILLION-IMP.-GAL.-A-DAY DE LAVAL MOTOR-DRIVEN PUMPS AT HAMILTON WATER WORKS

was the only concern which agreed to guarantee this efficiency. They had at that time been building this type of pump for about a year.

Mather & Platt are well-known English manufacturers of electrical and mechanical machinery and have been building turbine pumps since 1876, and are still one of the leading authorities in Europe. They and Sulzer Bros., of Switzerland, first introduced what is known as the hydraulic balance valve for providing against end thrust, about the same time, in 1906. With this system a disc is connected on the shaft beyond the last impeller on the discharge side and automatically provides against end thrust, no thrust bearings being required. It is now generally in use by the leading pump manufacturers all over the world.

These pumps also failed to meet their guarantees at the first time of testing. A test was made in August, 1914, and at the stipulated head each pump was approximately 500,000 gal. a day low in capacity, and 8% low in efficiency. The builders then substituted new impellers and diffusion vanes, this time designing them for 300-ft. total head instead of 285 ft., and they were again tested in August, 1915, but still fell short of the rated capacity of 6½ million gal. a day at a head of 300 ft. They gave slightly over this capacity, however, at 285 ft., with an efficiency of 76%, which was 4% lower than the guarantee.

On September 21, 1918, after further changes, another test was made on one unit and an efficiency of a little over 78% was obtained. In May, 1919, the second one was tested and the very good efficiency of 81.9% was obtained.

After the summer of 1915 it was realized by the engineers that the steam pumping capacity was inadequate, and A. F. Macallum, who was then city engineer, obtained estimates on a 15,000,000 gal. steam-turbine-driven pumping unit, with condensing plant, boilers and appurtenances, which he submitted to the Board of Control, but no action was taken.

Later Mr. Macallum resigned his position to become Commissioner of Works at Ottawa, and E. R. Gray was appointed to fill the vacancy. Both he and Mr. Bain continued

to urge upon the city officials the necessity of increasing the steam pumping capacity, which was only 13½ million Imp. gal. a day as compared with 26 million electrical. Moreover, the 57-year-old Gartshore pumps could not be relied upon, and for that matter the Osborne-Kelley pumps were in need of extensive repairs.

On August 3, 1916, at a joint meeting of the Board and a sub-committee of the Works Committee, it was decided to ask James Milne, chief mechanical and electrical engineer of the city of Toronto, to visit Hamilton and make a report as to the best method of increasing the city water supply. Mr. Milne, in his report, drew attention to the insufficiency of the steam pumping capacity and recommended the purchase of a unit of 15,000,000 Imp. gal. a day capacity, with the least possible delay. Mr. Milne submitted estimates on three different types, namely (a) vertical triple-expansion high-duty reciprocating pumping engines, (b) turbine-driven geared centrifugal, and (c) high-speed vertical-engine-driven centrifugal pumps, at costs, including foundations, boilers, buildings, piping, etc., of \$241,585, \$131,080 and \$142,105 respectively, and pointed out that a steam-turbine-driven geared centrifugal similar to those installed at the main and high-level pumping station in Toronto, would be more economical than the vertical triple-expansion or high-duty pumping engine, even though the steam consumption were greater, due to the much higher interest and depreciation charges which would have to be provided for the more expensive machine. So far as the vertical-engine-driven centrifugal was concerned, his report showed that not only was the first cost higher, but also the steam consumption.

Shortly afterwards a committee which included E. R. Gray and James Bain visited several cities in the United States for the purpose of obtaining information as to the merits of the two different types of pumping machinery and other information.

On September 4, 1916, Mr. Bain submitted a comprehensive report to the Board of Control on the whole water works situation, in which he reviewed the Hamilton water supply from its inception, including pumping machinery, mains, intakes, filtering basins, conduits and reservoirs. He recommended the installation of a duplicate pumping system, a new 48-in. discharge main to be laid from the Beach Pumping Station to the city which would enable 45 million gal. each 24 hrs. to be pumped, a new 72-in. steel intake to be carried well out into the lake, the abandonment of the so-called filtering basin due to its inefficiency, a new 72-in. conduit from the basin to the pumping station, also a connection to be not less than 48-in. from the Beach Pumping Station to the main leading from the Barton Reservoir to the distributing mains in the city.

Mr. Bain also reported adversely against the proposition submitted by the Dominion Power & Transmission Co. for the city to install a 750-k.w., 25-cycle turbo-alternator in the Dominion Power Co.'s generating station, which could be operated by steam furnished by the power company. The object of this was to maintain a duplicate source of power for the electrical pumps.

Mr. Bain, after pointing out that it would be necessary to install a unit of more than double this capacity to furnish enough power for the centrifugal pumps, gave other sound reasons why it should not be entertained, and recommended that tenders be called for a vertical high-duty triple-expansion pumping engine with a capacity of 20 million Imp. gal. in 24 hr. against a total head of 300 ft., and also on a steam-turbine geared centrifugal pumping unit of the same capacity, and other necessary minor machinery.

A month later the Hamilton Hydro-Electric System submitted a counter proposal to the city embodying the construction of a 20 million gal. reservoir on the mountain,

and mentioned the advantages which in their opinion such a scheme had over the installation of new steam pumping machinery.

When Mr. Bain was handed a copy of this report, he very ably showed the inaccuracy of many of the statements which were made, and among other things mentioned that while a reservoir was a very useful thing to have, without adequate pumping capacity to fill it, it would be of little use. He also submitted figures to refute many of the Hydro Commission's assumptions, with the result that in July, 1917, the Board of Control called for tenders on the following:

One 10 million Imp. gal. a day steam-turbine-driven centrifugal pumping unit.

One 10 million Imp. gal. a day electric-motor-driven centrifugal pump.

One 650-k.v.a., 3-phase, 25-cycle synchronous motor.

Two 750-k.w., 3-phase, 25-cycle transformers.

Switching apparatus.

Two 24-in. venturi meters.

One water-tube boiler.

Contracts were signed by Mayor Booker on October 22, 1917, with the Turbine Equipment Co., Ltd., Toronto, for one \$15-h.p. De Laval steam turbine connected through the medium of double helical speed-reducing gears to an 18-in., 2-stage De Laval pumping unit at a price including condensing machinery and auxiliaries, and all piping and valves inside the pumping station, and to be installed on foundations to be provided by the city, for the sum of \$52,517.

This same company were also awarded a contract for the 10,000,000-gal.-a-day centrifugal pumps, to be driven by electric motor, at a price of \$22,420, installed on city's foundations, including piping and valves, etc.

The contract for the 650-k.v.a. synchronous motor was awarded to the Canadian Westinghouse Co., of Hamilton. The Canadian General Electric Co. received contract for the transformers, etc., and Goldie & McCulloch Co., Galt, for the 400-h.p. water-tube boiler. A. W. S. Roberts, Toronto, representing the Builders Iron Foundry, Providence, R.I., was awarded the contract to supply the two 24-in. Venturi meters.

Deliveries on all the machinery was very much overdue, due to war conditions, and it was not until February, 1919, that the first shipment was made by the De Laval Steam Turbine Co., consisting of the electrical pumps. The installation of the complete unit, consisting of motor, pumps, Venturi meter, valves, piping, etc., was not completed until January, 1920.

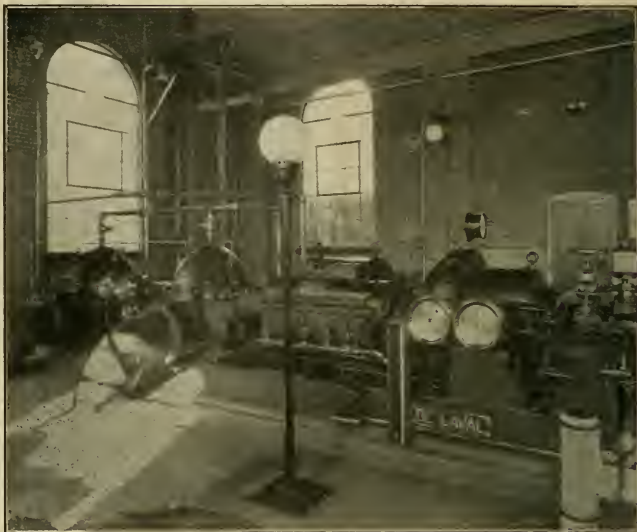
On February 5, James Bain and the writer conducted an official acceptance test, the average results of which were as follows:

Capacity in Imp. gal. in 24 hours	10,028,571
Discharge pressure	125.07 lb.
Suction lift	9.75 ft.
Total head	299.92 ft.
Input to motor	621.42 k.w.
Electrical h.p.	833
Water, h.p.	632.92
Motor efficiency	91.5%
Pump efficiency	80.4%
Combined efficiency of motor and pump, ...	75.98%
Speed	741.57 r.p.m.

Owing to this test being made under bad conditions, due to it being impossible to maintain a uniform speed, we made another test on February 8, during which the speed of the motor was fairly constant, and the following average results were obtained:

Capacity in Imp. gal. per 24 hr.....	10,596,154
Discharge pressure	125.65 lb.
Suction lift	9.7 ft.

Total head	301.21 ft.
Input to motor	662.7 k.w.
Electrical h.p.	888.34
Water, h.p.	671.67
Motor efficiency	94.5%
Pump efficiency	80%



TEN-MILLION-IMP.-GAL.-A-DAY STEAM-TURBINE-DRIVEN PUMPS AT HAMILTON WATER WORKS

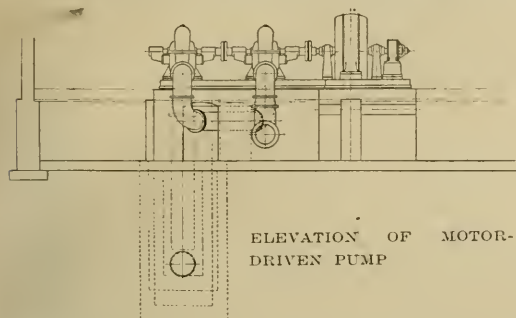
Combined efficiency	75.6%
Speed	750.23 r.p.m.

Readings were taken at intervals of 10 minutes over a 2-hr. period. The mechanical operation was entirely satisfactory and the unit was accepted by the city shortly after.

The Turbine Equipment Co. guaranteed a pump efficiency of 77 per cent., and in this connection it might be mentioned that as the pump manufacturers were limited to a speed of 750 r.p.m., it was necessary to use much larger pumps than for the steam-turbine-driven unit, in order to accommodate the larger diameter of impellers required, and, therefore, 20-in. pumps were specified as compared with the 18-in. used with the steam turbine. With the motor-driven unit, 31½-in. diameter impellers had to be used, whereas 27.7-in. impellers were large enough to give the head at 850 r.p.m., which was the speed of the reduction gear supplied with the turbine. The capacity of 10 million Imp. gal. a day was really too low for most efficient results with the large pump cases, which give a maximum efficiency at a capacity of approximately 17 million Imp. gal. a day. Under the circumstances, therefore, the efficiency of 80 per cent. can be considered quite satisfactory.

This machine consists of two 20-in. standard De Laval single-stage double-suction bronze-fitted pumps, with suction and discharge branches located in the bottom half of the pump casings. The bronze used in the impellers consists of 88 per cent. copper, 10 per cent. zinc and 2 per cent. tin. The usual De Laval labyrinth type of impeller and case renewable wearing rings are used, and the shafts, which are of open-heart steel, hammer-forged and ground, have renewable bronze sleeves extending from the hubs of the impellers to the outer ends of the stuffing boxes, thus entirely protecting the shafts from contact with the water. The shafts are equipped at one end with marine-type thrust bearings. 20-in. series pipe connects the discharge of the first pump with the suction of the other. It will therefore

be seen that instead of using what is known as a multi-stage pump consisting of two impellers in one casing, two single-stage pumps are used and these are mounted in tandem, the shafts of the first pump and the motor being connected by means of a flexible coupling, and the shafts of the two pumps in the same manner. The water is sup-



ELEVATION OF MOTOR-DRIVEN PUMP

plied to the first pump from a well 5 ft. square, located immediately below it, and this pump discharges the water at a pressure of about 60 lb. to the suction of the second pump, which boosts it to a pressure of from 125 to 130 lb., at which pressure it is sent to the city mains.

The impellers have the usual power-limiting characteristic which prevents an overload being placed on the motor should the head drop from any cause, such as low water in the reservoir or a broken main.

Characteristic curves plotted after the test are reproduced herewith and the very flat efficiency curve obtained is worthy of note. This is due to the absence of guide vanes, which were abandoned by the De Laval Co. several years ago. Certain dimensions of these pumps may be of interest.

The diameters of the pump shafts at the impeller hubs are $5\frac{1}{2}$ in., and at bearings $5\frac{1}{4}$ in.

The length of the straight bearings is 14 in.

The thrust bearings are 14 by $4\frac{1}{4}$ in., there being three thrust collars $5\frac{1}{4}$ in. in diameter.

The centre line of the impellers to the centre line of the bearings is $32\frac{1}{2}$ in.

The installation of the steam-turbine-driven unit was completed in January, 1920, and the machine was first turned over a few days later, and the mechanical operation was quite satisfactory. Mr. Gray soon after made preparations to have it officially started, and on April 23 Adam Brown, the city postmaster, who was one of the first water commissioners of Hamilton, visited the pumping station in company with the mayor and several members of the Board of Control and City Council, for this purpose. Mr. Brown was born in 1826, and was an active member of the Water Commission for a great many years, and was partly instrumental in having the first water works pumping machinery installed in that city. He was amazed when informed that the steam turbine operated at a speed of nearly 5,000 r.p.m., and still more when told that the pumps, which occupy about one-twentieth of the space required by the old Gartshore units, had three times the capacity of the two combined. Under the guidance of the contractors' representative he slowly opened the throttle admitting steam to the turbine, which very quickly came up to speed and was soon sending the full capacity of the pumps through the mains on its way to the city.

A banquet had been prepared in the large new store-room which had been built adjacent to the pumping station and which had been gaily decorated for the occasion, and after-dinner speeches were made by several of those present, including Mr. Brown, who reviewed the growth of the city and the necessary addition to pumping machinery, mains and reservoirs since the installation of the Gartshore pumps in 1859.

About a month later a few preliminary tests made by

the writer demonstrated that the machine did not quite meet the guarantees, and eventually it was found necessary to send a man from the works to make a few changes in the nozzles of the turbines and to rebucket one or two of the wheels.

When this work had been completed another preliminary test was made which showed that the highest duty was obtained at a capacity of 12,000,000 Imp. gal. a day, and the contractor made a request that the official test be made at this capacity, explaining that it was a great advantage to the city to have the 2,000,000-gal.-a-day surplus. Eventually an agreement was reached to have the test run at a capacity of 11,000,000 Imp. gal. a day. On October 30 Prof. Angus, of Toronto University, conducted a test for the city, who were also represented by their chief mechanical engineer, Mr. Bain, while the writer represented the contractor.

The Turbine Equipment Co. had made the following guarantees respecting duty in million foot pounds per 1,000 lb. of steam, including steam used by the auxiliaries:

Temperature of Condensing Water	Vacuum	Duty 305 ft.	Duty 225 ft.
70 deg. F.	28 $\frac{1}{4}$ in.	114.25	95
60 deg. F.	28 $\frac{1}{2}$ in.	116	97.4

This was based on a steam pressure at the throttle of 170 lb. gauge. The contractor also agreed to give the full capacity against a total head of 225 ft. by reducing the speed to 800 r.p.m.

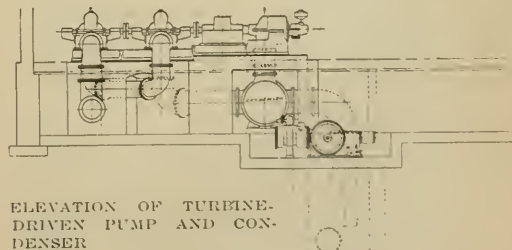
The conditions of the test were that the capacity should be measured by a Venturi meter, the head by a calibrated pressure gauge, and the suction lift by an accurate vacuum gauge. The total steam used, including that required by the vacuum and boiler-feed pumps, was to be charged against the turbine, and no allowance was to be made for heat returned to the boilers in the shape of boiler-feed water heated from the exhaust steam from the auxiliaries.

A bonus was to be paid to the contractor at the rate of \$1,250 for each million footpounds by which he exceeded his guarantees, and a penalty of the same amount for each million footpounds by which the machine fell below its guarantees.

Although the total head for which the pumps were required was 300 ft., they were designed for 305 ft. to allow for friction loss in the condenser and piping.

The contractor computed his duty on the basis of dry saturated steam being supplied at the turbine throttle.

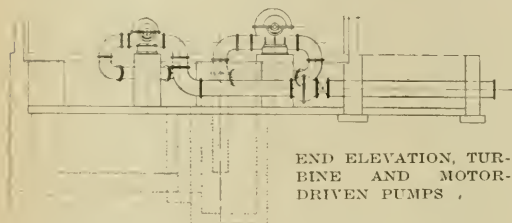
Instead of using the recorder supplied by the Builders Iron Foundry with the Venturi meters, a differential mercury gauge was connected between the inlet end of the meter and the throat, and the difference of pressures read directly to within 0.04 in. of mercury. Using the generally-applied Venturi-meter formula—that is to say, a co-



ELEVATION OF TURBINE-DRIVEN PUMP AND CONDENSER

efficient of 0.99—the velocity through the throat was computed from this pressure. Where H is the number of feet of water corresponding to the differential gauge reading, the throat velocity for the meter equals $1.022 (2GH)^{0.5}$. These readings were taken at 5-minute intervals, as also were the suction and discharge gauge readings.

The discharge gauge was calibrated by a dead-weight tester both before and after the completion of the test. Instead of the ordinary spring vacuum gauge, which seldom reads accurately, a mercury manometer was connected at a point just near the pump suction flange. A mercury vacuum gauge was also installed at a point just above the



END ELEVATION, TURBINE AND MOTOR-DRIVEN PUMPS

exhaust flange of the turbine, to register the vacuum, and a calibrated pressure gauge, also tested both before and after the duty trial, was connected in the steam piping near the throttle valve.

The steam used by the turbine, after being condensed, was pumped by the vacuum pump from the condenser to tanks placed on calibrated scales, where it was weighed at certain periods. Two tanks, each mounted on scales, were used, so that one could be filling while the other was emptying.

During ordinary operation the steam from the vacuum and boiler-feed pumps exhausts into a Cochrane heater and is used for heating the boiler-feed water, and during the test careful records were taken of the speeds of these machines every 15 minutes, and at the end of the duty trial of the main unit, which lasted 6 hours, the exhaust outlets of these two pumps were connected to a tank containing cold water. They were then operated at the same speeds again, and the rise in the level of the water noted, and their steam consumption thereby computed.

Fifteen-minute readings were taken on the steam pressure gauge and of the vacuum at the turbine exhaust, also of the turbine and pump speeds. The quality of the steam entering the throttle valve was determined by a throttling calorimeter.

Due to the boiler being quite a distance from the station in which the turbine and pumps are installed, the moisture content of the steam was unusually high, namely, 2.37%. As previously mentioned, the Turbine Equipment Co. had guaranteed their duty on the basis of dry saturated steam, and this was the subject of a dispute. Prof. Angus eventually allowed for all moisture over 1.5%, which is generally considered "commercially dry steam." This would mean that an allowance of 0.87% had to be made when computing the duty of the unit. The contractor, however, cited cases where 2% had been allowed for each 1% moisture, and pointed out that this was a generally accepted theory of steam turbine engineers, and Prof. Angus, after giving the matter careful consideration, finally agreed to it. This, therefore, was equivalent to an allowance for moisture of 2 times 0.87, or 1.74%.

The average vacuum reading recorded was 28.32 in. with 30.06-in. barometer, which is equivalent to 1.74 in. absolute pressure, and this was so close to the 28 1/4-in. equals 1.75-in. absolute referred to a 30-in. barometer, that a straight line variation of duty with absolute pressure was assumed, and therefore the guarantee duty reduced to 1.74 in. absolute is 114.32 million ft.-lb. as compared to the contractor's guarantee of 114.25 ft.-lb. at 1.75 in. absolute.

The average results of the trial were as follows:

Average capacity each 24 hr. in Imp. gal.	11,110,000
Head on discharge gauge	291.95 ft.
Suction lift	16.20 ft.
Correction for elevation difference in gauges	2.25 ft.
Total head	310.4 ft.
Steam Pressure	169.7 lb.
Vacuum	28.32 in.
Barometer	30.06 in.

Speed of pumps	845 r.p.m.
Water h.p., ...	725
Pump efficiency	80%
Brake h.p., ...	909
Steam consumption of turbine in lb. per hr.	11,901
Steam consumption of air pump	172
Total steam used per hr	12,476 lb.
Duty in million ft.-lb. per 1000 lb. of steam, corrected for moisture	117.16
Excess duty over guarantee in million ft.-lb.	2.84
Steam consumption per h.h.p. hr. of turbine and reduction gears	13.12

This entitled the contractor to a bonus of \$3,287, which was paid by the city immediately after acceptance of the machinery.

The steam turbine is of the De Laval latest design. Instead of the straight "multicellular" or pressure-stage type similar to that invented by Prof. Rateau, of Paris, which was originally adopted for the multi-stage machines, the first stage is of the "velocity" type, like a Curtis wheel; that is, there are two rows of buckets on the first wheel, with a row of stationary guide vanes between them for changing the direction of the steam. The remaining eight stages are of the pure impulse type. The 'buckets' are secured to the rims of the hydraulically-forged steel wheels by means of bulb shanks fitted into slots milled transversely to the wheels. They are drop forgings of a special alloy of nickel and copper, and each one can be removed without disturbing the others. The buckets of the velocity stage are secured by the well known dove tail method.

All the diaphragms containing the guide vanes are of cast iron and held in place by a seamless steel band. The guide vanes are of nickel bronze.

The shaft is a nickel steel forging, 6 in. in diameter, and revolves at a speed of 4725 r.p.m., which is well below its critical speed. It is supported in two bearings, 3 1/2 by 8 1/4 in., and 3 1/2 by 6 in., respectively. An adjustable marine-type thrust bearing is also provided at the governor end of the shaft.

To prevent the outward leakage of steam and the inward leakage of air, steam sealed carbon packing rings are provided. Leakage between stages is prevented by labyrinth packing.

The main governor is of the Jahn's type, mounted on a vertical shaft and driven by a worm gear from the turbine shaft. The valve is of the double-seated balanced-poppet type. Special mechanism is also furnished for changing the speed of the turbine wheel in operation. It consists of a cast-iron sleeve on which is turned a thread. This sleeve surrounds the governor spindle and there is a spring fitted inside it, and a hand wheel which operates on the thread outside. The speed is varied by increasing or decreasing the tension on the spring by screwing up or down on the hand wheel. The former lowers the speed and the latter increases it.

The machine is also equipped with a Schutte & Koertig quick-operating trip-and-throttle valve which acts in



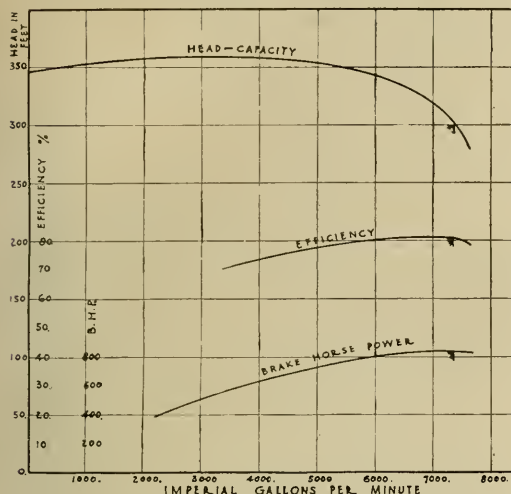
SECTION ON LINE A-A OF PLAN SHOWING TURBINE AND MOTOR-DRIVEN PUMPS

conjunction with a safety governor mounted in the end of the main shaft, independent of the main governor. This governor is generally set to close the trip-and-throttle valve at a speed of about 10% above normal.

The double helical reduction gears have a speed reduction ratio of 5.66 to 1, the pinion operating at 4725

r.p.m.; and the gear which connects to the pumps, at 850 r.p.m. The gear loss does not exceed $1\frac{1}{2}\%$, which represents tooth and bearing friction and windage.

The pinion is an oil-tempered nickel steel forging, much harder than the gear to compensate for the higher speed. The teeth are cut directly on the shaft.



CHARACTERISTIC CURVES FOR 20-IN. 2-STAGE PUMP AT HAMILTON WATER WORKS

The gear consists of a heavy cast-iron centre on which are shrunk two heat-treated seamless rolled-steel bands, the teeth being cut on these bands. The gear centre is secured to the 6 in. open-hearth forged-steel shaft by means of a taper fit and key. The diameter of the pinion is 4.625 in., and of the gear, 25.625 in. The total width of face of gear and pinion is 20 in. The tooth pressure at full load per inch width of face is 222 lb. The teeth are cut at an angle of 45 deg.

There are three pinion bearings, two of which are $3\frac{1}{2}$ by 10 in., and one $3\frac{1}{2}$ by 14 in. The gear has two bearings, $5\frac{1}{4}$ in. by 12 in. All turbine bearings and the pinion bearings are water-cooled and equipped with sight-feed oil glasses. They are supplied with oil from a gravity system. There is a positive gear-type of pump mounted on the lower end of the governor spindle which draws its supply from a reservoir located in the gear bedplate. This pump forces the oil through a Griseom-Russell cooler into a tank placed about 16 ft. above the centre line of the machinery, from whence it descends to a filter and from there flows to the different bearings and to the reduction gears. These gears are lubricated by a spray of oil issuing from small nozzles which are secured to a manifold inside the gear case. In this manner the oil is projected against the line of contact of the teeth on the entering side. The oil flows from the pinion bearings into the wells of the gear bearings and then to the large oil reservoir in the bedplate, to which also flows the oil from the turbine bearings. Suitable screens are located in this reservoir to prevent grit, etc., from flowing to the oil-circulating pump. Thus it is seen that the oiling system is what is known as continuous circulation.

The two single-stage 18 in. double-suction pumps are similar in every respect, with the exception of size, to the motor-driven units described previously. The impellers are 27.7 in. diameter, mounted on steel shafts which are $4\frac{1}{4}$ in. at the centres. Each shaft is supported by ring-rolled bearings, 4 in. diameter by $8\frac{1}{4}$ in. long, and 3 in. diameter by $9\frac{3}{4}$ in. long, respectively, the latter being of the marine thrust type, which have four thrust collars 4 in.

in diameter. The distance from the centre line of impellers to centre line of bearings is $28\frac{1}{2}$ in.

The condenser is of the water works surface type, containing 1,300 sq. ft. of cooling surface, consisting of 742 brass tubes (1 in. O.D.). The shell is 4 ft. 8 in. in diameter. It is located immediately under the turbine, an expansion joint connecting the turbine exhaust flange to the condenser steam box flange, both of which are 20 in. diameter. With this type the steam passes through the tubes and is condensed by the water flowing to the main pumps, all of which is drawn through the condenser on the outside of the tubes. Thus the entire capacity of the main pumps passes through the condenser, the shell of which is designed of suitable area to keep the friction down to a minimum. In this particular installation it does not exceed 2 ft. The water openings are 26 in. diameter and are located opposite each other. Cast-iron piping of this same size connects the inlet end with the large well which furnishes the supply, and the outlet end is connected to the suction of the first pump by 26 in. pipe, which is reduced to 18 in. about 3 ft. from the pump suction flange. The tubes are expanded into Muntz metal header at the steam box end, and secured at the other with packed glands and screw ferrules. The steam makes two passes through the tubes.

A 6 by 14 by 10 in. horizontal crank and fly wheel, wet air or vacuum pump, manufactured by the C. H. Wheeler Co., Philadelphia, removes the air and condensation; 6 in. piping connects the condenser to the vacuum pump inlet.

The condensation flows by gravity to the vacuum cylinder, there being no suction valves. The brass liner of the cylinder has a number of ports which connect with the suction belt extending around the cylinder and connecting with the suction opening at the top of the cylinder. These ports control the suction to the pump, being automatically closed and opened by the piston passing and repassing them. The discharge valves are also special and consist of about ten spring phosphor-bronze plates grouped in units on longitudinally slotted rods in which the valves fit. The tension is controlled by means of a pawl-and-ratchet device.

Both vacuum and hot water pump exhausts are connected to a Cochrane feed-water heater, which acts as a hot well and receives the condensation from the vacuum pump. This is automatically augmented by an outside cold-water supply, and after being heated by the exhaust steam from the vacuum and boiler feed pumps, is pumped to the boiler by the vertical, double-acting 9 by 6 by 10 in. brass-fitted boiler-feed pump similar to the Weir Admiralty type, which was manufactured by the Tod-Attwood Co., Toronto.

The pump house is about 200 ft. from the pumping station, and a 6 in. steam main is laid underground and enters the wall of the basement about 6 ft. below the ground level. It is here reduced to 4 in. and a Cochrane steam separator is installed close to the turbine. All the pumps have a separate suction well, 5 ft. square. Water is conveyed to them from a tunnel situated at the back of the station and delivered through a 30 in. sluice valve and conduit.

The discharge main from each of the De Laval units is 24 in. diameter, and there are 24 in. Chapman check valves and gate valves installed in each of these mains about 20 ft. from the pumps.

All the gate valves on the discharge mains of each of the electrical pumps are controlled through a system of counter-shafting, sprockets, chains and bevel gears by a 15 h.p. Canadian Westinghouse induction motor. Friction clutches enable each valve to be operated separately.

The old basins are no longer used for filtration purposes, having been converted into sand traps. The 20 in., 30 in. and 48 in. intakes are open from the basins to the lake and deposit any sand carried through them into these basins. The 72 in. steel intake which Mr. Bain recommended in his report as being necessary, has not yet been installed. The 48 in. intake is laid 2,200 ft. from the shore line under 35 ft. of water.

Transformers are installed in a separate room leading off from that in which the pumps are installed. They consist of two 750 k.w., 3-phase Canadian General Electric from 13,200 to 2,200 volts; two 500 k.w., 3-phase Canadian Westinghouse 13,200 to 2,200 volts; and seven 400 k.w., single-phase 13,200 to 2,200 volt made by the Packard Mfg. Co., St. Catharines.

There are two reservoirs connected with the city mains from the Beach Pumping Station: (1) The Barton Reservoir, with a capacity of 11,000,000 Imp. gal.; and (2) the James St. Reservoir, with a capacity of 1½ million Imp. gal. The latter is 65 ft. higher than the Barton Reservoir and is the one generally in use, the Barton Reservoir being held in reserve. The water from the pumping station does not flow directly into these reservoirs but is pumped into the mains, and the reservoirs are used to take care of peak consumption during the day, and are filled up at night. There are two connections to the Barton Reservoir, one 18 in. and one 20 in. The James St. Reservoir is connected to the mains by a 20 in. pipe line.

There are four mains leading from the Beach station to the city, 18, 20, 30 and 36 in. respectively.

For information pertaining to general features of the Hamilton water works, the writer is greatly indebted to James Bain, who, by the way, takes keen pride in the appearance of the pumping station, which is undoubtedly one of the finest in the country and will bear comparison with the majority of those to be found in the large cities in the United States. The row of lamp standards, about 10 ft. high, down the centre of the floor—with 12 in. diameter single frosted globes—looks especially handsome.

PHILADELPHIA CONVENTION AMERICAN WATER WORKS ASSOCIATION

APRIL 25 issue of "The Canadian Engineer" contained a tentative program for the Convention of the American Water Works Association to be held at Philadelphia, May 15-19, inclusive. The final program has now been issued and our readers may be interested to know that a few changes have been made from the preliminary schedule.

Monday, May 15, will be, as usual, devoted to registration and informal get-together meetings. In the evening there will be a reception and dance in the Clover and Red Rooms of the Bellevue-Stratford Hotel. This function will be under the auspices of the American Water Works Manufacturers' Association.

Tuesday, May 16

On Tuesday, May 16, John H. Gregory will not read his paper as previously announced. In the afternoon a trip to Valley Forge has been arranged for the ladies. Special conveyances will leave the Bellevue-Stratford Hotel (Walnut St. entrance) at 1:30 p.m., returning to Philadelphia at 5:00 p.m.

Wednesday, May 17

Wednesday, May 17, the technical session will be carried out in accordance with program as previously announced. In the afternoon a boat trip to Wilmington and return has been arranged for all the delegates. That same evening the ladies are to be entertained to a theatre party.

Thursday, May 18

The program for the Thursday evening session is as follows, when the papers given below will be presented:

"Purification of Water for Industrial Uses," by S. P. Powell. Illustrated with lantern slides.

"Lime, Soda and Zeolite Water Softening," by A. S. Behrman.

"Turbo-Centrifugal Pumps," by Richard Waller. Illustrated with lantern slides.

Immediately following this session which will adjourn at 9.30, the men will attend a smoker to be held in the Bellevue-Stratford Hotel while simultaneously the ladies will be entertained by a card party on the Mezzanine floor, under the auspices of the Water Works Manufacturers' Association and in charge of the ladies entertainment committee.

The Chemical and Bacteriological Section of the Association will be held on Thursday afternoon, May 18, at which the following papers will be presented.

"Water Softening by Base Exchange," by Edward Bartow, and Gerald C. Baker.

"Standard Methods of Water Analysis," by Jack J. Hinman, Jr., Chairman.

"Colloidal Chemistry in Relation to Water Purification," by Robert Spurr Weston, Chairman.

"Testing of Waterworks Materials and Supplies," by Thaddeus Merriam, Chairman.

The Friday afternoon session of the Chemical and Bacteriological Section will be carried out in accordance with the preliminary program.

INCREASE IN PIG IRON OUTPUT

DURING the month of March the output of pig iron in Canada showed a decided increase over production during the preceding month and established a record for the present year with a total of 41,733 tons, comprising 25,974 tons of basic pig iron, 10,123 tons of foundry iron and 5,636 tons of malleable iron. With the exception of 71 tons the output of basic iron was all used by the producing firms. Foundry iron, on the other hand, was largely produced for sale, the total under this heading being 10,080 tons, with only 43 tons made for the use of the firms reporting. Compared with the preceding month the production of basic iron was only slightly higher, but the output of foundry iron was almost 2,000 tons greater than in February. Malleable iron to the extent of 5,636 tons made during March was the first produced this year.

At the close of the month there were only three furnaces in blast, two at Sault Ste. Marie and one at Hamilton, the single furnace operated by the Dominion Iron and Steel Co. in February having been closed down before the end of March.

The revival of the iron and steel industry indicated in reports from the producing centres in February gained a little strength during March, and while the number of furnaces actually in blast in Canada at the close of the month was less than at the end of February, the output in Canada was appreciably higher, and to that extent more satisfactory.

Output of steel ingots and castings during March was only 29,941 tons, as against 42,388 in the preceding month. The decline was most marked in the production of basic open hearth steel ingots, which accounted for only 28,222 tons, compared with 40,935 in February. Bessemer castings and electric steel in March amounted to a little more than 1,000 tons, a slight increase over February.

NATIONAL HIGHWAY TRAFFIC ASSOC'N. MEETING

ALL arrangements have been completed for the 1922 Annual Meeting of the National Highway Traffic Association which will be held in the Assembly Hall of the Automobile Club, New York City, on Friday, May 12. At the afternoon session reports of National Committees will be presented on "Uniform Highway Signs," "Traffic Capacity and Widths of Highways Outside Municipalities," "Status of the Construction of Highway Curves and Recommended Practice to Increase Safety to Traffic." The report of the Executive Committee on "Highway Improvement Creed" will also be presented.

At the evening session an address on "The Railroad as an Operator of Highway Transport" will be delivered by Arthur H. Blanchard, president of the Association. Reports of National Committees will be presented on "Regulations Covering Speeds, Weights and Dimensions of Motor Trucks," "License Fees and Motor Vehicle Taxation," "Highway Transport Franchises" and "Highway Transport Clearing Houses." The meeting will be concluded by the election of officers for 1922-1923.

Statistical Record of Toronto Water, 1912-22

Laboratory Observations Recorded During Ten-year Period of Purification—Relationship of Hydrogen Ion Concentration to Residual Alum—Bacterial Concentration and Seasonal Variation in Filter Efficiency, With Reference to PH Concentration and Colloidal Content—Reduction in Typhoid Fever

By NORMAN J. HOWARD

Bacteriologist-in-Charge, Toronto Filtration Plant Laboratory

IN the city of Toronto there are two municipally-owned filtration plants and three separate chlorinating systems. The history of the purification of the water supply dates back to 1910, when the city was visited by a serious typhoid epidemic and a death-rate of 40.8 per 100,000 of population was recorded. As a temporary measure, a hypochlorite plant was installed and within two months the epidemic had abated. In the following year the death-

strated over and over again, and in 1921 the net saving effected by laboratory control of applied chemicals was sufficient to pay entire maintenance costs for the laboratory for a period of three years; in addition, the frequent examination of the water permits the more scientific application of chlorine.

Nature of Laboratory Work

The extensive nature of the work carried out in the laboratory of the plant can best be indicated by the number of examinations made in the past ten years. In 1921, when the slow sand system was first put into commission, 8,096 tests were made. This figure has yearly risen, and in 1921 no less than 21,028 samples were analyzed. During the 10-year period the total number of examinations made was 136,302 and included routine, chemical, bacteriological, physical and microscopical examination of the raw, filtered and chlorinated water; examination of well supplies, sewage and ice samples; chemical analysis of alumina sulphate, alum sludge, boiler compounds and incrustations; experimental work on the corrosive action of chlorine and alumina sulphate on various metals; the sterilization of water by chlorine, potassium permanganate and other reagents; the effect of mechanical and slow sand filtered water upon the growth of algae; a study of the hydrogen ion concentration of water and its relationship to seasonal changes in the filtration process; colloidal alumina occurring in mechanically filtered water; and a large number of observations on the occurrence of taste.

Methods of Analysis

Standard methods as laid down by the American Public Health Association were used so far as possible, not so much because they were regarded as satisfactory, but for the purpose of uniformity. Chemical methods, generally speaking, were found to be satisfactory, but bacteriological

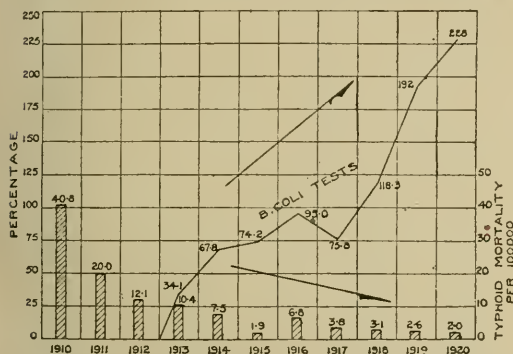


FIG. 1—TYPHOID MORTALITY, 1910-20, IN TORONTO, AND YEARLY PERCENTAGE INCREASE IN B. COLI SAMPLES POSITIVE IN 1 C.C. OF RAW LAKE ONTARIO WATER AS COMPARED WITH 1912

Prior to 1912 systematic examination of raw water had not been undertaken. Shaded columns indicate typhoid mortality.

rate was down to 20.8. As a result of the epidemic Allen Hazen was consulted in an advisory capacity, and he recommended slow sand filtration, to be followed by sterilization. The plant was commenced in 1910 and put into commission January, 1912. Within a few months from this date the demand in the city exceeded the working capacity of the plant, and as a result raw and filtered water were intermittently supplied.

For a period of two years the subject received considerable attention, and in 1914 R. C. Harris, Commissioner of Works, placed the matter before the City Council and was successful in getting the necessary appropriation for the construction of an additional plant, which was started in the spring of 1914 and taken over by the city in the summer of 1918. The new plant was of the drifting sand type, the combined capacity of the two plants being 108 million gallons, with an actual working capacity of 88 million Imperial gallons. At present that is barely sufficient to meet the continually increasing demands, and the early construction of an additional plant is under consideration by the Commissioner of Works.

The purpose of this paper is to state from a laboratory viewpoint observations recorded between the years 1912 and 1921, covering a period of ten years. During this time extensive routine and research work were undertaken. From a purification point of view, the successful operation of the plants and the daily examination of large numbers of samples have proven of considerable value to the city. The economic value of the laboratory has been demon-

TABLE 1—NUMBER OF EXAMINATIONS MADE YEARLY BY TORONTO FILTRATION LABORATORY

1912	8,096	1917	15,041
1913	9,382	1918	15,831
1914	9,848	1919	16,635
1915	10,292	1920	18,073
1916	12,076	1921	21,028

Total number of examinations, 136,302.

TABLE 2—NUMBER OF BACTERIA PER C.C. GROWING ON GELATINE, 3 DAYS AT 20 DEG. C.

	Raw Water	Slow Sand Filtered Water	Percentage Reduction
1912	5,992	599	91.1
1913	36,454	202	98.6
1914	23,635	246	98.9
1915	31,305	452	98.6
1916	33,275	272	99.1
1917	26,386	200	99.2

tests had to be modified, tests for B. Coli being regarded as particularly unsatisfactory. The substitution of oxgall in 1912 for lactose broth considerably decreased the number of fermenters; but it was found that practically the whole of the fermenters that did occur, confirmed out typical strains of the colon group. When comparisons were made

between lactose oxgall and lactose broth, results showed that the latter medium produced approximately 20% more fermenters, out of which at least 8% confirmed out. Neither medium has been regarded as satisfactory, lactose oxgall being too inhibitory and lactose broth too favorable for overgrowths.

The introduction of small amounts of sodium taurocholate or sodium cholate in quantities up to 0.5% has given favorable results, producing a media not too inhibitory.

TABLE 3—AVERAGE NUMBER OF BACTERIA PER C.C. GROWING ON STANDARD AGAR, 24 HOURS AT 37 DEG. C.

	Raw Water	Slow Sand Filtered Water	Percent-age Reduction
1914	103.53	3.11	96.9
1915	347.67	1.85	99.5
1916	280.00	2.90	98.9
1917	179.58	2.32	98.7
1918	356.30	2.20	99.1
1919	715.11	2.37	99.7
1920	724.51	2.35	99.6
1921	1,036.49	5.15	99.5
	Raw Water	Drifting Sand Filtered Water	Percent-age Reduction
1918	369.50	53.40	85.4
1919	833.00	38.86	95.3
1920	413.33	25.19	93.9
1921	566.37	26.29	95.2

ory and particularly favorable to the propagation of the colon group.

It has been frequently observed when using lactose broth for the presumptive B. Coli test no gas formed in 24-hour samples, but abundant gas formed in 48-hour tubes, which persistently failed to produce confirmatory results. When this occurred in Lake Ontario raw and filtered water, it has been said to be the result of overgrowths, but when occurring in chlorinated water was probably caused by spore-formers belonging to the sporogenes-welchii group.

It is possible that when a particular stage of gas development in the broth tube is reached, the medium becomes so acid or alkali, that bacteria belonging to the colon group are destroyed or so devitalized as to lose their reproducing properties. Certain types of alkali-forming organisms can be isolated which are able to grow in a distinctly acid medium, and it is probable that the so-called overgrowths are not the result of the predominance of alkali-forming bacteria, but rather indicates their ability to reproduce under conditions unfavorable to the colon group. In support of this theory it has been demonstrated in the laboratory that certain lactose broth cultures which had formed gas but failed to produce acid organisms on a solid medium, could be rejuvenated by frequent transplantings into broth tubes and made to reproduce typical strains of B. Coli. A study of this subject with special reference to the hydrogen ion concentration of the medium both before and after inoculation is to be undertaken in the near future. Chambers¹, when investigating the inhibitory nature of certain media in the growth of B. Coli, recently published an interesting paper on the subject, in which he states that in a 0.4% glucose broth medium, lethal acidity occurs at a p_H concentration of 4.9-5.1, the most favorable for development being 6.0-7.0; inhibition due to alkalinity begins at 7.0-7.6. Preliminary laboratory observations in Toronto would appear to confirm these opinions.

For many years complete confirmatory tests were made on all gas-formers, the classification being divided into three groupings: (1) Typical B. Coli communis; (2) B. Coli communior; (3) non-typical organisms belonging to the colon group.

¹ Chambers, W. H. Annual report Missouri Botanical Gardens, 1920.

Confirmed typical B. Coli was determined on Houston's Flaginac test² (Fl. fluorescence in Greubler's neutral red broth; Ag. acid and gas production in lactose broth; indol production in peptone broth; ac. acidity and clotting of litmus milk). In addition to this, dextrose and saccharose broth tubes were inoculated.

As the number of laboratory tests increased it was found impracticable with a limited staff to carry on the exhaustive confirmatory work, which sometimes involved 100 sub-cultures daily, and consequently the brief methods as suggested by the American Public Health Association were adopted. Confirmed B. Coli hereinafter mentioned consists of three positive reactions: (1) Formation of gas in lactose broth; (2) acid-forming colonies in litmus lactose broth or rebiplagar (neutral red, bile salt, peptose, lactose, agar); (3) sub-culture and fermentation of lactose broth. In the face of evidence to the contrary, it is not suggested that the organism isolated is typical B. Coli, but rather one belonging to the colon group.

The custom quite frequently met with in American practice of making rapid and incomplete tests for the isolation of the colon bacillus is not to be commended, too much being taken for granted. In laboratory reports one frequently finds figures relative to the presence or absence of B. Coli. Such reports would be more explicit and of greater scientific value if details of tests were published. The results could then be more intelligently interpreted.

For the enumeration of bacteria, standard gelatine and agar and Houston's rebiplagar³ were used, the first two having a + 1.2 acid reaction. The use of gelatine plates at 20 deg. C. was discontinued chiefly on account of the enormous growth of psychrophilic organisms which developed in the winter months, producing counts in excess of 100,000 per c.c., and which were of no sanitary significance. Quite often counts of 250,000 per c.c. occurred with B. Coli absent in 100 c.c. This organism was worked out in the laboratory and described by J. Race⁴ and would not grow in a temperature above 27 deg. C.

Standard agar at 37 deg. C. has always given satisfactory results. For the enumeration of intestinal bacteria Houston's rebiplagar has been found the most valuable media in use, and can be used either for enumeration purposes or confirmatory B. Coli plates, it being superior to

TABLE 4—EXCREMENTAL BACTERIA PER C.C. GROWING ON REBIPLAGAR, 24 HOURS' INCUBATION AT 37 DEG. C.

	Raw Water	Slow Sand Filtered Water	Percent-age Reduction
1914	4.99	0.061	99.0
1915	14.48	0.080	99.4
1916	19.85	0.097	99.5
1917	26.07	0.170	99.4
1918	26.50	0.250	99.0
1919	41.02	0.158	99.6
1920	34.41	0.092	99.7
1921	29.09	0.119	99.6
	Raw Water	Drifting Sand Filtered Water	Percent-age Reduction
1918	17.06	4.22	75.20
1919	30.26	2.31	92.35
1920	16.84	1.12	93.30
1921	21.70	1.26	93.50

lactose litmus agar and more economical and simpler to prepare than endos medium.

Routine Work

Routine work included daily tests on the raw, filtered, pre-chlorinated and chlorinated water. The chlorination

² Houston, A. C. Report on results of the chemical and bacteriological examination of the London waters for the month ending November 30, 1908.

³ Houston, A. C. Studies in Water Supply.

⁴ Race, J. Journal Canadian Public Health Association, 1912.

of the city supply is outside the jurisdiction of the filtration laboratory, this being in charge of the Directory of Laboratories of the Department of Public Health. Close co-operation has always existed, the Director being kept informed of any abnormal changes in the quality of the water prior to final treatment. The application of alumina sulphate, chlorine prior to filtration, and chlorination of the island supply during the summer months, was directly controlled by the laboratory.

In most cities alum is applied to the water for clarification purposes, but in Toronto it was originally employed on account of heavy bacterial pollution of the raw water and also at times when turbid conditions existed which periodically followed abnormal meteorological conditions. In 1921 experiments showed that chlorine could be safely substituted for alum and applied to the raw water prior to filtration through the drifting sand plant, at such times as

Increase of population in the various municipalities within a considerable distance of Toronto, many of whom discharge their sewage effluents into Lake Ontario.

In the laboratory survey of Lake Ontario, completed in 1921, it was shown that the raw water was more or less seriously polluted from Long Branch to Scarboro, a distance of approximately 16 miles, 8 miles east and west of the present location of the water works. Samples taken 1½ miles from shore in 65 ft. of water were included in the survey, and at times showed heavy pollution. This condition was forecasted in 1911 by the Board of Water Commissioners² and again in 1912 in the report of the Commissioner of Works³, and there would appear to be no reason to suppose that it will not go on increasing so long as Lake Ontario is regarded as the normal receptacle for the discharge of putrescible matter.

It is not suggested that this condition only applies to

TABLE 5—YEARLY PERCENTAGE OF SAMPLES SHOWING B. COLI IN RAW AND FILTERED WATER

Slow Sand, Raw Water										
	100 c.c.	10 c.c.	1 c.c.	0.1 c.c.	0.01 c.c.	0.001 c.c.	0.0001 c.c.	0.00001 c.c.	0.000001 c.c.	0.0000001 c.c.
1912	78.8	50.3	18.3	3.2	0.00	0.00	0.00	0.00	0.00	0
1913	81.2	54.6	24.6	4.9	0.00	0.00	0.00	0.00	0.00	0
1914	87.4	61.0	30.7	8.6	0.99	0.00	0.00	0.00	0.00	0
1915	91.4	60.2	31.9	8.2	1.60	0.30	0.00	0.00	0.00	0
1916	96.4	68.7	35.8	10.5	0.98	0.00	0.00	0.00	0.00	0
1917	92.7	67.1	32.2	8.5	2.60	0.00	0.00	0.00	0.00	0
1918	94.7	66.2	40.0	15.5	3.90	0.66	0.00	0.00	0.00	0
1919	98.0	83.1	53.0	28.4	12.50	4.00	0.33	0.33	0.33	0
1920	96.7	83.3	60.1	37.9	18.60	8.17	2.94	1.31	1.31	0
1921	98.7	93.1	72.7	41.8	22.00	9.90	3.00	1.00	1.00	0

Slow Sand, Filtered Water					
	100 c.c.	10 c.c.	1 c.c.	0.1 c.c.	0.01 c.c.
1912	50.5	20.9	1.90	0.0	0
1913	33.2	7.5	0.30	0.0	0
1914	35.2	8.9	1.30	0.0	0
1915	46.4	11.1	1.70	0.0	0
1916	56.9	11.5	0.65	0.0	0
1917	59.8	14.4	0.32	0.0	0
1918	60.6	17.2	0.66	0.0	0
1919	75.5	27.4	4.00	0.0	0
1920	85.9	46.7	9.15	0.0	0
1921	86.5	44.6	12.50	1.7	0

Lake Ontario, it being a common practice throughout the American continent, in spite of many state and provincial laws prohibiting its practice. No solution would seem to be in sight for the following reasons: (1) The financial stringency; (2) the expressed desire of municipalities to withhold the spending of large sums of money on disposal works pending further development of sewage purification; (3) the cost and frequent inefficiency of the sterilization of sewage effluents.

Drifting Sand, Raw Water						
	100 c.c.	10 c.c.	1 c.c.	0.1 c.c.	0.01 c.c.	0.001 c.c.
1918	94.4	67.6	35.3	14.1	1.6	0.33
1919	98.6	81.2	52.8	23.4	8.6	1.60
1920	96.7	80.4	53.6	24.2	8.5	3.90
1921	97.7	91.7	67.0	35.3	13.2	5.90

Drifting Sand, Filtered Water						
	100 c.c.	10 c.c.	1 c.c.	0.1 c.c.	0.01 c.c.	0.001 c.c.
1918	88.7	52.1	19.1	1.0	0.00	0.00
1919	92.0	60.0	21.7	4.0	0.66	0.33
1920	88.5	60.9	25.9	6.2	1.30	0.00
1921	72.2	46.4	22.2	6.0	1.00	0.00

the water was physically good. By doing this a water of satisfactory biological content, free of suspended matter, was obtained and considerable economy effected. This policy was found to be thoroughly sound and practical but it has never been used at the expense of the quality of the effluent, which consideration has always been regarded as of first importance.

The actual application of chemicals is controlled by chemical and physical analysis of the raw water, the nitrogen as ammonia test giving an accurate index as to the probable bacteriological quality of the water. Lake Ontario is subject to varying degrees of pollution, the intensity of which can be gauged by this test. Pollution at the intake is dependent upon the flow of lake currents, which are controlled by prevailing meteorological conditions.

Bacteriological Results

A study of the bacteriological figures over a period of ten years shows the pollution of Lake Ontario to have yearly increased, following the normal industrial development and

Again, modern practice in America regards the purification of the water supply as more practical and economical than the purification of sewage before its discharge into a stream⁴. Providing sewage effluents do not contain offensive chemical compounds and by-products, and the purification of the water supply involves no insurmountable difficulties, this would seem to be practical, but it would be dangerous to accept such a policy without a complete sanitary survey having been first undertaken.

The effect of the pollution in Lake Ontario upon the filters can be seen by a study of the accompanying tables, the efficiencies of the plants being slightly lower each year as the pollution has increased. In view of the fact that the

²Report of Board of Water Commissioners, Toronto Water Works, 1912.

³Report of Commissioner of Works on extension of Toronto Water Works System, 1913.

⁴Gillespie, P. Dilution in treatment of sewage. "Canadian Engineer," No. 8, Vol. 42, 1922.

filtered water is finally treated with chlorine before consumption, this cannot be regarded as a serious matter, although in time should it become necessary to increase greatly the amount of chlorine for sterilization purposes, difficulties may occur in preventing taste during susceptible periods. At the present time the filtered water is of satisfactory quality and particularly suitable for final treatment with chlorine.

Physical Conditions

Physical examination of the raw and filtered water was made daily and proved of value in following the operation of the filters. The slow sand plant has at all times yielded an effluent clear, bright and free of turbidity. The effluent from the drifting sand plant was clear and bright, and only on rare occasions following storms of unusual severity did turbidity pass the filters. The condition of operation occurring in the drifting sand plant involves a high rate of filtration (150 million Imperial gallons per acre per day) and no sedimentation; consequently in storm periods very careful operation was found necessary to prevent the passage of turbidity through the filters.

Microscopic Examination

In the early days of the slow sand plant, microscopic examination was made daily and afforded excellent opportunities of following the loss of head occurring in the filters. Of recent years, on account of increased work, only seasonal and special examinations were made. At no time has the microscopic content interfered with the operation of the filters. Occasionally in the summer months particularly in July, August and September, slight taste occurred following the presence of volvox and uroglena. Throughout the year, especially in the early spring and fall

TABLE 6—INDICATED NUMBER OF B. COLI IN RAW AND FILTERED WATER PER 1 C.C.

Slow Sand		
	Raw Water	Filtered Water
1912	0.496	0.038
1913	0.720	0.013
1914	2.000	0.024
1915	35.140	0.031
1916	2.470	0.020
1917	3.480	0.014
1918	11.360	0.027
1919	378.020	0.068
1920	1,535.510	0.134
1921	1,267.760	0.310
Drifting Sand		
	Raw Water	Filtered Water
1918	6.12	0.317
1919	114.32	4.180
1920	869.51	2.359
1921	752.39	1.680

months, diatoms were present in considerable numbers, asterionella, fragillaria and cyclotella being the most common; generally speaking they were not in sufficient numbers to cause a taste, although after chlorination in the summer months a slight taste has periodically been noticed in the treated water. Amongst the other types frequently found in the raw water were synedra, diatoma, tabellaria, melosira, microcystis, coelosiph-aerium, unabacna, tetraspora, hydrodictyon, ulothrix, dinobryon, vorticella, codonella, and several types of rotifera, crustacea and infusoria.

Chemical

Chemical examination and general analysis involved a considerable amount of work, and, as previously stated, was of material assistance in controlling the application of chemicals, the cost of alum in 1920 amounting to \$55,000. By substituting chlorine for alum in 1921, an actual saving of \$35,000 resulted.

Complete sanitary analysis was made on the raw and filtered water and the results as recorded in tables present interesting reading. It will be observed that the chlorides have risen from 7 p.p.m. in 1912 to 10 parts in 1921, a

figure quite in harmony with the increased bacteriological content of the water. The slow sand plant gave a water somewhat purer than the effluent from the drifting sand plant.

The general reduction of the chemical figures in the filtered water was satisfactory, particularly as regards the albuminoid nitrogen and the oxygen absorbed, representing as they do a reduction in the nitrogenous and carbonaceous matter. The increase in the nitrates in the slow sand plant pointed to greater oxidation, doubtless caused by the nitrification process involved.

Alkalinity as calcium carbonate was reduced by approximately 2 p.p.m. in the drifting-sand plant, and probably in time, when the calcium and possibly magnesium carbonates normally present in the sand are used up, a greater reduction will be shown.

At no time has the theoretical reduction of 6.675 p.p.m. for each grain of applied alumina sulphate per gallon been attained. Laboratory tests on the raw water using methyl red as an indicator, have given an actual reduction of 6.2 parts for each grain per gallon, but the same water after filtration through the drifting sand plant has rarely shown a reduction of over 2 parts per million.

Dissolved oxygen was reduced by the slow sand plant, but increased after passage through the drifting sand plant. In the warm weather raw water was frequently super-saturated, the effect of this being noticed in the drifting sand plant, air pockets occasionally forming in the extractor system, particularly when a high dosage of alum was being applied.

Residual Alum

The question of residual alum in filtered water was first raised at Albany at the 37th convention of the New England Water Works Association, and arose out of a discussion on a paper presented by the writer on the operation of the drifting sand system in 1918.

At that time a strong attitude was taken by several well-known sanitarians, who claimed that the passage of alum in any form whatever pointed to a defect in the filtration system involved. The matter received considerable attention in the laboratory in 1920, and was the subject of a special paper by Howard and Hannon¹, followed by another the following year by Wolman and Hannon², the latter paper dealing entirely with the theoretical considerations involved. It seems an extraordinary fact that this question received publicity only after 20 years' operation of mechanical filters, and of recent date has been the subject of extensive investigation and controversy throughout the American continent. It is now conceded that the effluents from a majority of mechanical plants contain alum in colloidal form. Heretofore the basis of discussion was limited to a study of the alkalinity of the water, it being generally conceded that, providing an excess of alkalinity existed after treatment, no alum could pass the filters if sufficient sedimentation had been allowed.

In Toronto, laboratory experiments first demonstrated that in a water of similar chemical content, sedimentation was unnecessary for removing residual alum or securing bacteriological efficiencies, the same results being obtained in the filtered water after four minute's and four hours' sedimentation. Similar experiments were made on a colored water containing 30 p.p.m. of color and 50 parts of alkalinity. It was found that the color was reduced by filtration to 8 when using 2.25 grains per gallon of aluminum sulphate, after a contact period of 5 minutes. This latter experiment was undertaken to secure comparative in-

¹Howard, N. J. Description, operation and purification effected by drifting sand system in Toronto during 1918. Journal New England Water Works Association, Vol. 32, No. 4.

²Howard, N. J., and Hannon, F. Alumina hydrate in mechanically filtered water. "Canadian Engineer," May 13, 1920.

³Wolman, A., and Hannon, F. Residual aluminum compounds in water filter effluents. Chemical and Metallurgical Engineering, Vol. 24, No. 17, 1921.

formation on the removal of color, special references to the question of a definite period of sedimentation being necessary.

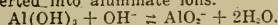
It is not suggested that all colored waters could be so treated, but in cases where prolonged periods of sedimentation are allowed, experiments could be well undertaken to demonstrate the feasibility of reducing the time. On large plants a reduction of time in treatment is one of considerable importance, and in new works great economy could be effected if it were found practical to reduce the area of sedimentation basins.

The whole question would seem dependent upon the hydrogen ion concentration, the nature of the color, and the colloidal content of the water involved. Lake Ontario water contains no color, so this subject has no bearing upon the local treatment of the water supply. As regards residual alum experiments, we have been unable to find a water which, after treatment with aluminum sulphate with subsequent filtration, has not contained colloidal alumina. A summary of observations previously reported was as follows: (1) Effluents from all treated water examined gave positive reactions; (2) raw water from Lake Ontario and Lake Erie gave negative reactions; (3) intensity of positive reaction slowly diminished on long standing, but after six months was still perceptible; (4) freezing did not affect the reaction, neither did boiling; (5) filtered through six thicknesses of Whatman's No. 5 filter paper, the reaction was still obtained, there being evidence of adsorption of sol by the paper; (6) the sols freely ascended bihulous paper—over 13 cm. in 48 hours; (7) water of ϵ_{H} 8.0-8.6, yielding no reaction if brought into contact with alumina gels or if passed through a filter paper which had adsorbed alumina sols, will yield positive reactions; (8) Non-reacting Al in solution (normally present in Lake Ontario water) can be brought to react by slightly acidifying, boiling, cooling and restoring the original ϵ_{H} value by cautious addition of ammonium carbonate. The presence of iron may interfere with this test as Haematoxylin combines with iron in preference to alumina when both are present together in reactive form. These reactions can be accounted for if we assume:

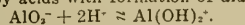
(a) Haematoxylin enters into reaction with alumina sols but not with aluminate ion.

(b) Alumina gel is readily peptised in presence of OH-ion, even at ϵ_{H} 8.0.

(c) Alumina sols are not stable in presence of OH ion, but are converted into aluminate ions.



(d) Aluminate ions are stable in presence of OH ion, but are decomposed by acids with formation of aluminum ions.



(e) The degree of dispersion of the sols is probably greater

1—With increased O H-ion concentration.

2—After severe filtration.

(f) Higher dispersion accelerates the course of reactions.

In Toronto we have been able to demonstrate that the residual alum after filtration was a hydrate in colloidal form, which subsequently became an aluminate the exact nature of which has not been determined.

In many cities the raw water has a low hydrogen ion concentration of approximately 7, and is soft or colored. The addition of a coagulant prior to filtration still further lowers this figure, making the water slightly acid, and when the alum passes through the filter in colloidal form it becomes corrosive, combining with iron in the pipes and subsequently precipitates in the city mains, producing a highly discolored water.

By correcting the hydrogen ion figure immediately after filtration by the addition of lime, this could be prevented. The chief question involved, however, would be the advisability of treating the water prior to filtration instead of adjusting it after filtration. It should be borne in mind that the most favorable hydrogen ion concentration for filtration purposes is between 6.5 and 7.4, precipitation commencing at the first-named figure and the iso-electric point occurring approximately at the latter figure. The introduc-

tion of lime before filtration would render the water a little more difficult to treat, and also allow the passage of a greater amount of colloidal alum through the filters. It would thus appear to be a question entirely for the local chemist and engineer to decide.

The water of Lake Ontario has a hydrogen ion concentration of 8-8.4 according to season of the year, and after filtration through the drifting sand plant contains a residual alumina in colloidal form which has no corrosive properties, does not produce any after-precipitation in the mains, has shown no evidence of protecting bacteria against the sterilizing effect of chlorine, and can be said to be of no sanitary significance.

In the experimental-work carried out in the laboratory the reagents used were fresh alcoholic solutions of extract of logwood (1%), haematoxylin (0.3%) and Nx6 acetic acid.

TABLE 7—AVERAGE* MAXIMUM AND MINIMUM TURBIDITIES RECORDED IN RAW AND FILTERED WATER
Slow Sand, Raw Water

	Maximum	Minimum	Average
1912 .....	.....	.....	8.86
1913	700	1	19.99
1914	180	1	8.30
1915	150	1	5.80
1916	175	1	8.20
1917	85	1	6.20
1918	160	1	6.20
1919	105	1	7.76
1920	145	1	4.93
1921	195	1	7.74

Slow Sand, Filtered Water

	Maximum	Minimum	Average
1912 .....	.....	.....	0.86
1913	6.0	0.5	0.59
1914	1.0	0.5	0.50
1915	1.0	0.5	0.50
1916	0.5	0.5	0.50
1917	0.5	0.5	0.50
1918	0.5	0.5	0.50
1919	0.5	0.5	0.50
1920	0.5	0.5	0.50
1921	0.5	0.5	0.50

* These are based upon figures recorded at 9.30 a.m. daily, when the samples were collected for examination. Higher maximum figures were actually recorded in several years.

Drifting Sand, Raw Water

	Maximum	Minimum	Average
1918	160	1	7.15
1919	130	1	7.94
1920	110	1	4.17
1921	95	1	4.02

Drifting Sand, Filtered Water

	Maximum	Minimum	Average
1918	18.0	0.5	0.660
1919	11.0	0.5	0.630
1920	14.0	0.5	0.598
1921	3.0	0.5	0.520

The presence of alumina was determined by the formation of a blue to purple color, which after acidification turned to pink or brown. In the absence of alumina a deep pink color resulted, which turned to yellow on addition of the acid. In all cases control tubes were found necessary on account of the extremely sensitive nature of some of the reactions.

Operation of Filters

The operation of the filters has not involved any change of a radical nature in the past few years, nor have any difficulties occurred which have not, or could not, be overcome. The chief problem encountered, which has affected the output of both plants, has been occasional storms of great violence, resulting in the precipitation of large quantities of fine sand and vegetable debris. Slow sand filters have usually been more affected on account of

the difficulty of sand cleaning, particularly in winter months, this being one of the chief considerations involved, when it was decided to extend the purification system in 1914, by the addition of the drifting sand filters. This latter system, on account of the simplicity in cleaning, is able to recover more quickly and presents certain advantages not possessed by the slow sand plant.

The operation of both plants would be greatly facilitated if a sedimentation or pre-filtration system were in existence, as practically the whole of the heavy suspended matter would be removed before the raw water entered the filters. This would however, involve double pumping and certain engineering difficulties. The custom of raking the surface of the slow sand beds has greatly prolonged the life of the filters. This practice, while being common in America, is prohibited in Europe, it having been demonstrated in London and elsewhere that it seriously impairs the bacteriological efficiency of the filters. Similar conditions have been noticed in Toronto after a series of storms which deposited heavy layers of silt on the surface of the beds and rendered frequent raking necessary in order to maintain the output of the plant. While the general efficiency of the filters was at times lowered, it was not considered a matter of importance in view of the fact that all effluents were finally sterilized with chlorine.

The problem of sand cleaning in the slow sand filters during the winter months was partly solved in 1913 by the use of portable sand washers, but during prolonged periods of unfavorable weather, difficulties are still experienced in maintaining the output of the plant. The increase in pollution of raw water during the past few years had the effect of greatly increasing the applied alumina in the mechanical plant, which was originally designed to operate on a one grain per gallon basis. The amount of alum found necessary to deal with a raw water which periodically contained in excess of 1,000 B. Coli per c.c., was 2.5 grains per gallon. This amount could be satisfactorily applied for definite periods, but its prolonged use had a clogging effect on the filters, particularly in warm weather. As a result it was found more practical and economical to adopt the policy common on many plants of clarifying the water with a moderate dose of alum, which also caused considerable bacteriological reduction, and depend upon chlorine for sterilization. During the summer of 1920 and part of 1921, by operating on this basis the output of the plant was maintained well above normal working capacity, and good water supplied during the whole period involved.

Bacterial Concentration

On a large plant such as Toronto possesses, which includes two entirely different systems of treatment, the seasonal differences in purification are of absorbing interest. The greatest bacterial concentration in Lake Ontario occurs in the summer and early fall months, when the water temperature is highest. This is the reverse of the conditions noted by Jordan¹, who, however, states that the variations in the bacterial flora have been observed from season to season which may partly be local in their significance. Houston has also observed that pollution is worse in the winter months in the rivers supplying London, and it may be that this applies to certain rivers, but not to the Great Lakes or similar bodies of water, where the pollution is largely local and is more or less controlled by meteorological conditions which control the direction and flow of the water.

The seasonal variation in the bacterial flora has been reported upon by Wells², who found that the number of B. Coli present in human feces increased enormously as the temperature rose, reaching its maximum in the month of August. Wells states that "the remarkable degree to which three independent curves are parallel cannot be at-

tributed to mere chance. It must be admitted that the seasonal distribution of B. Coli is related to the similar seasonal variation of B. Coli within the intestine." The figures during the past ten years show that in Toronto the total number of bacteria and the B. Coli content of the raw water follows the same curve as indicated by Wells.

The figures relative to the indicated number of B. Coli present in the raw water for each month of the year covering a period of 6 years were included in an article by the writer³, and showed enormous variations. Based upon the examination of 1822 samples, of which not less than 24 samples were examined each month during the years 1915-1920, the results were as follows:

INDICATED NUMBER OF B. COLI PER 1 C.C.

January	8.32	July	662.09
February, ...	7.42	August	2,126.13
March	11.01	September	690.28
April	19.13	October	23.22
May	36.07	November	96.12
June	54.34	December	191.33

In previous yearly reports it has been pointed out that the highest degree of bacterial removal occurred in the slow sand plant during the warm summer months and in the drifting sand plant in the winter months. In other words, as the pollution increases and the water warms up, the efficiency of the slow sand plant improves and is maintained; inversely the quality of the drifting sand plant goes back. Following is a study of the average bacterial count occurring each month in the raw and polluted water during 1920-1921:

SLOW SAND, 1920-1921

Average Number of Bacteria per C.C. growing on Agar at 37 deg. C.

	Raw Water	Filtered Water
January	610.7	6.77
February	474.25	4.89
March	337.03	3.63
April	368.84	4.32
May	554.67	2.87
June	779.26	2.98
July	1,893.62	1.87
August	1,644.62	3.22
September	1,525.22	2.76
October	885.91	4.64
November	912.58	4.19
December	598.74	4.48

At periods during the past two years the mechanical plant has been operated largely on a clarification basis and also with chlorine, consequently the filtered water figures are of little value in making a deduction as to efficiency and are not given. As previously stated, the raw water, even allowing for increased pollution, requires considerably more applied alum in the summer months to produce bacterial efficiency. During these periods B. Coli appears to pass through the filters more freely than other types of bacteria, a condition frequently recorded on other plants.

Wolman and Hannon⁴ have suggested that the seasonal variations in bacterial efficiency are probably controlled by the hydrogen ion concentration and the temperature of the water. Their paper includes figures, and a discussion on both slow and rapid sand filtration, and says in part:

"If the data presented above are valid, what effect may we be led to expect in such processes as sand filtration from season to season? Theory would certainly indicate that it should be more difficult to get good results from our filters in the warmer months when the p_H is higher. In actual practice this is frequently the case, but it is sometimes ascribed to 'colloidal difficulties.'"

¹Howard, N. J. Relation of raw water to endemic typhoid fever. "Canadian Engineer," Vol. 40, No. 3, 1921.

²Wolman, A., and Hannon, F. Further observations on p_H in natural waters. Chemical and Metallurgical Engineering, Vol. 25, No. 11, 1921.

³Jordan, H. E. Fifteen years' filtration practice in Indianapolis. Proceedings of the 13th Annual Convention of the Indiana Sanitary and Water Supply Association.

⁴Wells, W. Firth. Seasonal variation in multiplication rate of micro-organisms within the body. American Journal of Public Health, Vol. 11, No. 7, 1921.

Later they state: "Evidence confirmatory of the hypothesis that efficiency of filtration and coagulation processes vary inversely with r_n is given by the data presented in an excellent paper by Jordan. The latter clearly points out that filtration, taken as a whole, falls off in effectiveness as the temperature rises, a phenomenon which Jordan associates with biological activity."

Experience has indicated in Toronto that their opinions, as judged by results obtained from the mechanical plant, are worthy of consideration, but there has been little or no indication that the r_n controls the purification of the slow sand filtered water in either summer or winter months, and the basis of their conclusions in this respect is not apparent. To the writer it seems likely that problems frequently encountered in water purification are largely controlled by local conditions.

Is it not possible that of recent date too much has been attributed to the r_n concentration, and not enough to

TABLE 8—AVERAGE AMOUNT OF ALUMINUM SULPHATE ACTUALLY APPLIED

1918	1.027 grains per Imp. gal.
1919	1.254 grains per Imp. gal.
1920	1.225 grains per Imp. gal.
1921	1.298 grains per Imp. gal.

the 'colloidal' properties of the water involved? In dealing with water problems in general, from a colloidal viewpoint, the recent paper by Pirnie¹ is very enlightening and certainly calls for further investigation in the study of this comparatively unknown subject. Granted that physical and colloidal chemistry is very closely allied, and that the r_n concentration does actually control the situation in certain types of water. The writer is of the opinion that in dealing with a water similar in character to the raw water in Toronto, the solution to coagulation and the resultant purification rests more in the field of colloids than in a study of the r_n concentration of the water. This opinion is based upon the facts that the hydrogen ion concentration of the water is approximately 8 in the winter months and 8-8.4 in the summer months, and there is no definite indication that this small variation in the hydroxyl ions is sufficient to account for the marked seasonal variation in filter efficiency.

On the other hand, the bacterial concentration is the highest during the months that difficulties are experienced in maintaining the efficiency of the drifting sand plant, and it is an established fact that this pollution is due to sewage of recent origin. The differences in the colloidal content of sewage under warm and cold weather conditions are too well known to dwell upon, and it seems reasonable to assume that the organic content of the raw water varies from day to day. In addition to the changes in the organic content, similar changes occur in the organic colloids, and these by virtue of their varying degree of absorption might have much to do with the seasonal changes noted.

The organic colloids found in sewage carry negative charges and are highly complex and unstable. When the biological content of the raw water is high, it is apparent that the presence of enormous numbers of negatively charged colloidal molecules would require an increased quantity of alumina, which is said to be positively charged, if an effluent of bacterial purity is to be attained. An excess of alumina would increase the positive charges present and tend to re-establish electrical equilibrium.

It should be observed here Wolman and Hannan state: "It is believed that alumina used for mechanical filtration is negative when the r_n of the solution is greater than 7.5 (Sorensen's scale)." If their contention is correct, the above-mentioned suppositions are open to criticism.

The slow sand plant has always given an effluent of higher purity during the summer months, when the raw

water is most heavily polluted and the water temperature much higher. The porosity of the filters is greater in the winter months, the length of filter runs ranging from between 10 and 60 days, according to physical conditions, while in the summer months 10 days is about the maximum.

Biological activity would seem to control slow sand purification, the nitrification process being accelerated in the summer months when the water is warm and contains considerable numbers of microscopic organisms, particularly by algae, zoogloea and diatoms. Algae are rarely present in the winter months, but diatoms show a considerable increase at certain times. Both these types of organisms play an important part, and by splitting up CO_2 to obtain carbon, they liberate nascent oxygen, which has a marked germicidal effect on low forms of bacterial life.

The cause of seasonal variation in the efficiency of plants is still a matter of conjecture, and doubtless when the study of physical and colloidal chemistry has further developed, a solution will be forthcoming. The suggestion at the present time that waters in general can be definitely treated on a r_n or colloidal basis would seem to the writer to be very doubtful.

Chlorination of Water

Chlorination of the water has presented but few difficulties and has been continually carried out in Toronto since March, 1910. As in all other cities where the treatment has been effectively controlled, typhoid fever has been mastered and the mortality rate rendered practically negligible. Certain conditions in chlorination have been observed, chiefly that smaller doses are required in winter months, the dose varying from approximately 0.2 in cold weather to 0.375 p.p.m. in warm weather. Treated water examined in 100 c.c. shows almost complete sterilization in the winter months, while in the summer occasional 48-hour fermenters occur which persistently fail to confirm out or even to reproduce on a solid medium.

The question as to the relationship of spore-formers (more frequently present in the summer months in Toronto raw water) to this condition is receiving considerable attention in the laboratory. Chief among the problems en-

TABLE 9—TEMPERATURE OF RAW WATER AT INTAKE, SHOWING MAXIMUM, MINIMUM AND AVERAGE FIGURES

	Maximum	Minimum	Average
1912	62.6	32.05	41.5
1913	67.1	32.05	43.1
1914	66.2	32.05	42.9
1915	68.5	32.05	43.9
1916	62.6	33.80	41.7
1917	60.0	32.05	39.9
1918	64.0	32.05	41.8
1919	64.0	34.00	43.9
1920	70.0	32.05	42.1
1921	71.0	33.00	44.6

countered is the prevention of taste, which periodically develops under conditions quite often showing no similarity.

Examination of the city sewage containing industrial waste has indicated the presence of phenols, and it has been assumed that this is the chief condition involved. Taste does not usually occur in the summer months, it being more pronounced in the spring and early fall months. It seems highly probable that if the cause originates from the industrial wastes in the sewage, the non-occurrence of taste in the summer months is due to greater biological activity, which of recent date, particularly at Milwaukee² has been shown to prevent taste even when sewage originally contained phenols in large quantities. The cause of taste has been under investigation for many years in Toronto, but to date (apart from the phenol theory) no definite cause has been established.

¹Pirnie, M. Application of Colloid Chemistry to study of filter effluents. Journal American Waterworks Association, Vol. 9, No. 2, 1922.

²Seventh annual report of the Sewerage Commission of the City of Milwaukee, for the year 1920.

TABLE 10—AVERAGE CHEMICAL FIGURES IN RAW AND FILTERED WATER

Slow Sand Raw Water

AMMONIACAL NITROGEN

	Free	Album- inoid	Total	Nitrates	Chlorides	Oxygen Consumed 4 hours at 80 deg. F.	Oxygen Dissolved	Alkalinity as Ca Co ₃
1912	.010	.069	.079	.110	8.10	.520	12.60	97.70
1913	.006	.042	.048	.092	8.18	.341	12.40	96.80
1914	.010	.052	.062	.100	8.70	.440	12.60	96.20
1915	.011	.050	.061	.104	9.30	.460	11.80	96.80
1916	.011	.046	.057	.078	9.57	.500	12.57	97.08
1917	.010	.064	.074	.087	9.58	.050	12.60	96.15
1918	.013	.070	.083	.050	9.89	.510	12.48	94.24
1919	.024	.071	.095	.105	9.41	.425	12.59	92.53
1920	.018	.071	.089	.108	9.74	.395	12.98	93.52
1921	.024	.087	.120	.109	10.13	.450	13.04	94.06

Slow Sand Filtered Water

AMMONIACAL NITROGEN

	Free	Album- inoid	Total	Nitrates	Chlorides	Oxygen Consumed 4 hours at 80 deg. F.	Oxygen Dissolved	Alkalinity as Ca Co ₃
1912	.005	.048	.053	.110	8.04	.37	.....	.....
1913	.006	.042	.048	.092	8.18	.34	.....	96.80
1914	.004	.032	.036	.120	8.80	.34	.....	96.70
1915	.003	.029	.032	.128	9.35	.32	.....	96.80
1916	.002	.022	.034	.102	9.57	.31	.....	97.30
1917	.004	.032	.033	.119	9.60	.31	.....	96.10
1918	.001	.041	.042	.080	9.87	.34	11.01	94.41
1919	.003	.044	.047	.124	9.39	.26	11.29	92.57
1920	.003	.052	.055	.124	9.78	.27	12.22	93.08
1921	.003	.063	.068	.128	10.00	.30	11.69	94.28

Drifting Sand Raw Water

AMMONIACAL NITROGEN

	Free	Album- inoid	Total	Nitrates	Chlorides	Oxygen Consumed 4 hours at 80 deg. F.	Oxygen Dissolved	Alkalinity as Ca Co ₃
1919	.023	.070	.093	.111	9.37	.43	12.65	92.48
1920	.016	.072	.088	.109	9.66	.41	13.18	93.15
1921	.016	.082	.098	.105	9.91	.42	13.11	93.42

Drifting Sand Filtered Water

AMMONIACAL NITROGEN

	Free	Album- inoid	Total	Nitrates	Chlorides	Oxygen Consumed 4 hours at 80 deg. F.	Oxygen Dissolved	Alkalinity as Ca Co ₃
1919	.012	.048	.060	.113	9.35	.25	12.69	90.27
1920	.010	.053	.068	.108	9.69	.26	13.05	90.94
1921	.015	.068	.083	.106	9.94	.34	13.03	92.91

Reduction of Typhoid Fever

As has been previously stated, following the treatment of the water a remarkable decline in the typhoid rate occurred, and a further pronounced drop following the enforced pasteurization of the milk supply.

Toronto's Gross Typhoid Mortality Rate Per 100,000 of Population

1910* 40.8	1914 7.5	1918 3.1
1911 20.0	1915† 1.9	1919 2.6
1912† 12.1	1916† 6.8	1920 2.0
1913 10.4	1917 3.8	1921 3.0

*Raw water chlorinated following epidemic.

†Raw water partly filtered and chlorinated.

‡City by-law enforcing pasteurization of milk became effective.

§Military camp in Toronto, where several cases developed and which were scored against city.

A point of very great interest is that while the pollution of the raw water has increased abnormally for the past ten years, yet the curve of typhoid mortality has yearly declined. A graph prepared by the writer in 1921 is reproduced herewith as Fig. 1.

It is obvious from this that had the water not been effectively treated, typhoid fever, instead of having become endemic, would have become an increasingly epidemic disease. To the combined results of filtration and chlorination must be largely ascribed the practical elimination of typhoid fever within the city of Toronto. In 1910, prior to treatment of the water being undertaken, a mortality rate of 40.8 per 100,000 of population was recorded, and in

1912 the rate had declined to 3.0, a striking testimony of the efficacy of filtration and sterilization of the water supply.

The writer is desirous of placing on record appreciation of the many laboratory reports dealing with water works operation, which have been received during recent years. In particular the reports of Sir A. C. Houston, published by the Metropolitan Water Board, London, England, have proved of material use in dealing with problems frequently encountered on the works and in the laboratory.

Good progress is being made in connection with the work of developing power at Sturgeon Falls on the Mattagami River. This development will be completed early in December at the present rate of progress, and is intended to preclude any possibility of the gold mines of the Porcupine field being short of power during the coming winter.

On Tuesday morning, May 9, at the Spring Meeting of The American Society of Mechanical Engineers a public hearing was arranged for the discussion of the three additional power test codes which have reached this stage of their development during the past year. Last May at Chicago this Committee, of which Fred R. Low is chairman, presented codes on general instructions, steam engines, and evaporating apparatus. It now presents codes on definitions and values, displacement compressors and blowers, and hydraulic power plants. These codes have passed through six successive revisions in reaching their present form.

STERILIZATION OF SWIMMING-POOL SUPPLIES

By J. Van Benschoten

Of Wallace & Tiernan, Ltd., Toronto.

PROPER disinfection of swimming-pool supplies is now being recognized as of paramount importance, because all swimming pools are mediums for the transmission of diseases such as typhoid fever, dysentery, eye and ear infections, and venereal diseases.

The operation of swimming pools can be divided into two classes, namely the "fill-and-draw" system and the "recirculating" system. In either case, sterilization is indispensable.

With the "fill-and-draw" system, the pool is filled and emptied at intervals, the time depending principally on the size of the pool, the number of bathers, the class of patronage and the care taken in enforcing showers and general sanitary conditions. However each bather is subject to pollution from previous bathers. This system can be modified so that a continuous incoming and outgoing supply of water gradually changes the entire supply. If this incoming water supply is properly sterilized, good results are obtained.

With the "recirculating" system, the pool is continuously recirculated, filtered and sterilized; particles in suspension and impurities are thus removed and the water kept in good condition. As filtration and sterilization are both used, the water is not only kept clean and sparkling, but all germ life killed. Where the supply is pumped from the pool through filters, then sterilized, heated and returned to the pool, the pumps and filters should be of sufficient capacity to take care of the pool content every eight to ten hours. This latter time period varies proportionately with the patronage, etc., as in the previously explained system.

Returning again to the "fill-and-draw" system and looking at it from a financial point of view, every gallon of water added to the pool must not only in most cases be paid for but, in addition, it must be heated from the incoming temperature to approximately 76 deg. F. A fair price for water is 15c. per thousand gallons, and for coal, \$15 a ton; hence if a 50,000-gal. pool is emptied weekly, the yearly cost should approximate some \$2,000.

Where pools adopt the "fill-and-draw" system and refill every 24 hours, they may pass a sanitary inspection, but where the water supply is held for a greater length of time, it is necessary to resort to sterilization. Taking everything into consideration, this method is extremely costly to operate even with continuous dilution, and more especially is this the case when the water has both to be purchased and heated.

In the "recirculating" system, the same water is pumped, filtered and sterilized continuously, and the sanitary standard maintained at all times. The water supplies of pools adopting this method have only to be changed after long intervals, as the filters keep the water clean and sparkling continuously, while the sterilizing agent kills the germ life. From a sanitary point of view, therefore, the water is always safe.

Liquid chlorine is the most efficient, as well as the least expensive, water sterilizing agent. It is effective on turbid water and hence, should the filters at any time become inoperative, sterilization can still be depended on to safeguard the supply. In view of the fact that liquid chlorine is today recognized as the proper sterilizing agent for municipal water supplies, is this not sufficient argument in favor of its use for swimming pools?

There are apparently only two other sterilizing systems which have been used to any extent for this purpose, namely, "ultra-violet-ray" and the "ozone."

"Ultra-violet-ray" is not effective on water supplies where turbidity or color are present, as any suspended matter prevents penetration of the rays. Should the recirculating and filtering equipment fail at any time, this system of sterilization immediately becomes worthless. Sterilization only takes place within the apparatus and has no effect on the water in the pool; another disadvantage is that the cost of equipment and operation are extremely high.

"Ozone" has the same disadvantage as to cost and has not proved itself particularly applicable to swimming pool supplies here.

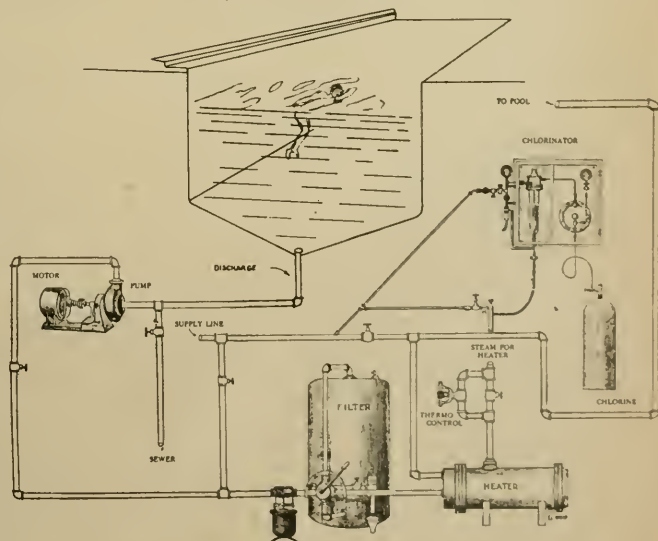
In the chlorination of swimming pools, only a minute quantity of chlorine is necessary to destroy the life of the existing bacteria, the average dose being from five to ten pounds per million gallons of water. There are no tastes, odors or other unpleasant features, while the chemical and physical qualities of the water are left unaltered. Last, but not least, chlorination is effective throughout the entire pool.

The California State Department of Health consider swimming pool disinfection an absolute necessity, and liquid chlorine the most effective agent for this purpose.

MUNICIPAL LEAGUE MEETS AT FORT WILLIAM

AT the annual convention of the Municipal League held at Fort William, Ont., on April 27, the delegates were welcomed by President Thomas Hughes, who in his address stated that as the years went on district roads were becoming steadily better and such improvement, he believed, was largely due to the work of the League and to the splendid co-operation which existed between the members of the league and the government roads department. He advocated action to induce the government to take over the care of the main trunk roads in the district.

J. C. Meader, resident engineer in charge of the road work being done in the district by the Northern Development branch of the Government, spoke upon road conditions. He pointed out that the Government had not yet announced its 1922 road program, but he had reason to believe that the Government was prepared to carry the entire upkeep of certain trunk roads, including the following: Dawson road, Nipigon road, Scott highway, Oliver road and Arthur street road.



TYPICAL SWIMMING POOL RECIRCULATION SYSTEM

IMPORTANCE OF SURFACE FINISH ON ROADS*

Effect of Impact — Causes and Remedies for Surface Irregularities — Longitudinal Joints Increase Strength of Road — Maintenance of Good Surface Finish

By H. Eltinge Breed,
Consulting Engineer, New York City.

WE KNOW that impact is one of the principal causes of destruction of our pavements. If the wheels of vehicles are smooth and the pavement surface is smooth there is no damaging impact from traffic. The road stands up even though it be weak in proportion to the volume and weight of traffic it must carry. But let surface irregularities develop, and no matter how strongly built, the whole pavement soon shows the effects of wear. We build our roads on an average to withstand a pressure of 800 pounds per lineal inch width of tire. Yet, if an unevenness in surface of only $\frac{1}{4}$ in. occurs, the impact of one road wheel of a 5-ton truck may exert an impact pressure upon the road of 20,000 lb. Under pressure, the unevenness becomes a depression and the edges spall and break, causing holes and so on until the pavement is badly damaged.

In order to lessen impact we must build and maintain smooth surfaces. How can it be done? Close scrutiny of work and infinite attention to detail are essential. Then there are certain general remedies suggested by the general causes of unevenness, specific remedies being tried by different states or on different jobs, and different methods of work and machinery.

Causes of Uneven Surfaces

There are five general causes of uneven pavement surfaces:

1. Foreign materials in the aggregate, which, failing to amalgamate, are pushed out, leaving holes and depressions.
2. Non-uniform aggregates, which cause non-uniform wearing resistance of traffic, and subsequent depressions in the weaker places.
3. Poor workmanship in striking off and finishing.
4. Cracks, longitudinal and transverse, due to frost action, changes of temperature or unequal bearing power in the subsoil.
5. Uneven joints, perhaps the most common cause of surface trouble, due often to the piling up of joint material or to difference in elevation of slab surface.

The general remedies for surface unevenness are as obvious as the unevenness itself, and therefore, perhaps, as often neglected, they are specifications exacting good material and good workmanship. More and more we are getting these on paper, but the problem is their application to the job, because that is where the human element enters. How solve the personal equation between engineer and contractor? The answer is at once made that the relationship should be one of co-operation and mutual endeavor toward a common end, the best possible road. But as long as the idea of profit precedes social welfare as an aim in our economic life, just so long are we often going to have the contractor trying to get all he can out of a job, while the engineer is trying to make him put all he can into it. So sometimes the letter of the specification is violated, and frequently the spirit. When all engineers know their job so well that they can show contractors easier and better methods of doing their work, and when all contractors regard highway work as a legitimate industry and not a financial gamble, then we shall have that adherence to specifications that will insure good work and smooth surface.

Preserving Surface Finish

Three other general methods of preserving good surface finish, once it is obtained, are the use of steel reinforcement, the division of the road longitudinally, and the wider spacing of joints with the use of dowels.

*Paper read at the American Road Builders' Convention, Chicago.

Steel reinforcement gives the road greater bearing power and greater resistance to frost action, and it also offsets irregularities and weaknesses in the sub-soil. By helping to preserve the integrity of the pavement, it minimizes any tendency towards cracking, which is of course one cause of surface unevenness.

The division of the road longitudinally increases its beam strength about four-fold. Observation reveals that longitudinal cracks are not found in slabs 9 and 10 ft. wide, though we have all encountered them in slabs beyond that width. The reason for this difference is still conjectural, but until it is ascertained we would do well to be guided by results hitherto obtained, and build our concrete roads in two longitudinal sections.

Transverse joints being a prolific source of trouble, it is well to diminish their number as far as possible through the use of the longer slab. This wider spacing of joints becomes feasible through the use of steel reinforcement to meet the temperature stresses of the slab. The use of dowels gives stability to the joints and holds the surface even. The submergence of joints one inch below the surface has proven unsatisfactory. Devised at first to secure a smooth surface and permit the use of a finishing machine, it seemed admirable until subsequent expansion crowded and crushed the concrete above the joint material, leaving a badly ravelled and spalled joint. The best method that I have found of making a joint is to submerge the joint material until after the screed or finishing machine has passed over it; then to lift the joint material slightly above the surface with long fingered tongs; then to finish the joint with the split float or split roller, rounding the concrete next to the joint material with an edging tool.

Specific application of these general principles is found in the requirements of such states as Delaware, Pennsylvania, and New York. In these states, and in others, the specifications exact good workmanship by allowing a maximum of only $\frac{1}{4}$ -in. depression in 10 ft. of pavement tested with a straight edge. The use of the straight edge on green concrete reveals depressions that must be rectified to insure good results. These states specify materials with such exactness so as to preclude the use of foreign materials in the aggregate and also of non-uniform aggregates. They design the roads so as to minimize the danger of movement in the slab and resulting cracks, and they give special attention to the placing of joints and to the suitability of the machinery in use.

All these precautions were taken on the road built last summer in Old Bennington, Vt., by the Fred T. Ley Co., and so far not the slightest indication of any surface unevenness has appeared on it. This tends to support the writer's belief that we shall be able to build roads within necessary financial limits that under the traffic permitted by law, will be practically indestructible.

Method of Surface Finishing

The actual method of finishing is of course important in securing a smooth surface. Some road builders prefer to use the finishing machine with the roller and belt. It is essential that the roller be light. A too heavy roller pushes the crown out of the pavement, and spoils the surface. Most specifications call for a weight of from 12 to 15 lb. per foot length. Some builders omit the roller, using only the machine. The writer's experience is that the roller helps. One advantage of the finishing machine is that a dryer concrete can be used with it, which gives greater strength to the pavement. It also gives more uniform results than can be obtained with a green gang, and seems in general more fool-proof than the hand method. Still, many prefer to strike off with the hand screed, using the roller and belt. This has the advantage of making one piece of plant the less to get out of order and where a heavy screed is used in the hands of competent workmen it gives as smooth a finish as the finishing machine.

With either method the board belt gives unquestionably the best finish. The bow belt, however, can give good results. Proper belting takes off not only the water, but also the clay loam, ballance, etc., that tend to form scale on the surface.

Engineer's Library

SEWERAGE AND SEWAGE TREATMENT

Reviewed by

Dr. George G. Nasmith,
of Gore, Nasmith & Storrie,
Consulting Engineers, Toronto

SEWERAGE AND SEWAGE TREATMENT—By Harold E. Babbitt, M.S., Assistant Professor, Municipal and Sanitary Engineering, University of Illinois; Associate Member American Society of Civil Engineers. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. First edition, 531 pages, 6 by 9 in., 186 figures. Cloth: \$5.00 postpaid.

This book, as stated in the preface, is a development of class room and lecture notes. The first twelve chapters relate to design, including pumps and pumping stations; specifications and contract and the usual necessary hydraulics of sewers and details of construction. The general principles of design, construction costs and maintenance are covered in a concise and readable manner. The rational method of determining the flow into storm sewers is dealt with in an interesting way and is compared with other well-known flow formulae such as McMath's from which the results do not greatly differ. The extent and intensity of storms is also treated with sufficient clearness.

In the hydraulics of sewers, prominence is given to Kutter's formulae which is essential from the student's standpoint. In the office, however, it is much simpler to rely upon tables such as Williams & Hazen which in the hands of an experienced person are preferable.

The last nine chapters deal with the composition and properties of sewage, methods of treatment including dilution, screening, sedimentation, septicization, oxidation, activated sludge, chemical precipitation, and disinfection.

Naturally in a book of this size, discrimination must be shown in the selection of material. The writer does not desire to be critical but believes that text books which devote more space to the chemical and biological principles involved in sewage disposal and a clear description of what each method of sewage disposal, is capable of accomplishing under different circumstances would accomplish much more in bringing up an intelligent body of sanitary engineers than books which stress mere empirical methods and formulae, necessary as these undoubtedly are. The student needs to know the 'why' as much, if not more, than the 'how'. If engineers and operators possessed a clearer conception of the nature of sewage disposal processes and their limitations, together with an exact knowledge of what they desired to accomplish, there would be fewer failures of sewage disposal works.

Dunbar's book on sewage disposal covered the field of sewage disposal in a way that has unfortunately been unequalled since his day. He clearly understood what went on in every biological sewage disposal process; he would never have failed as Babbitt has to clearly distinguish, for example, the radical difference between ordinary septic action and that decomposition or digestion which goes on in deep tanks as described by Watson at Birmingham.

There are some notable omissions in the book. The inoffensive digestion of sludge by Watson is a notable development which receives no space. Nor is any reference made to the development of the brush trickling filter in Toronto, though for seven years in North Toronto that material has permitted of the treatment of six million gallons of settled sewage per acre per day as against two million gallons on the stone medium formerly used.

In fact, too little space is devoted to the trickling filter, which has by no means lost its place as a valuable method under certain conditions, though enthusiastic advocates of the activated sludge process would have us be-

lieve it had. Nor is sufficient space devoted to dilution which must come into each and every sewage disposal scheme.

With the exception of the space devoted to activated sludge one would not gather that the art of sewage disposal was largely if not altogether a British product. One has only to name the septic tank, the contact bed, the trickling filter, the activated sludge process, the Travis tank,—predecessor of the Imhoff tank,—the new mechanical aeration process and sludge digestion to realize that every great step in the art has been made in Britain. Yet of the illustrations used in the book few are those of well known classic examples either in Great Britain or even the United States.

The chapter on sludge disposal, the most difficult problem in connection with sewage, is much too short. It is interesting to note that the sludge press, which has been in operation for thirty years, still holds its own as the best method for mechanically drying sludge;—and it seems crude.

The book is well illustrated with excellent cuts and the author has been fairly successful in carrying out his intention as described in the preface. To the writer the book seems to contain that academic quality so frequently met with in books written by University teachers, namely, an impression that they have been studying the problem from a distance, and it does not possess that elusive atmosphere of authority which sometimes finds its way into a book written by the man who has been on the job, who has built, experimented and ruminated over his results and who from long observation and experience knows his subject.

ENTROPY AS A TANGIBLE CONCEPTION—An elementary treatise on the physical aspects of heat, entropy and thermal inertia for designers, students and engineers and particularly for users of steam and steam charts by S. G. Wheeler, Eng. Lieut.-Commander, R. N. Published by the D. Van Nostrand Co., New York. First edition: 76 pages; illustrated: 5 1/2 by 8 1/2 ins.; cloth. \$3.00.

CALGARY ENGINEERS MAKE PRESENTATION TO SECRETARY

AT the monthly meeting of the Calgary branch of the Engineering Institute of Canada, held on April 28, a wrist watch was presented to A. L. Ford of the Water-powers Branch of the Department of the Interior, who has been Secretary of the local branch for the past two years. A splendid turn-out of members was present at the meeting, indicating the high esteem in which Mr. Ford is held. In making the presentation P. J. Jennings, chairman of the Calgary branch, referred to the manner in which the activities of the branch had been extended during the past two or three years, attributing a great deal of the success to the efforts of Mr. Ford. Mr. Ford is succeeded in the important position of Secretary by J. A. Spreckley of the Reclamation Service. An interesting paper was read at the meeting by W. H. Snelson, agricultural engineer of the Reclamation Service, describing the experiments conducted at Brooks, Alta., by the Dominion Government, for the purpose of determining the correct duty of water which should be applied by irrigation to the various kinds of crops in Alberta. The paper was illustrated by five charts, showing the results actually obtained during the past four years. Mr. Snelson emphasized the important effect of fertility due to rotation, on the amount of water required to produce the same crop result. He also explained the method of ascertaining the depth of water actually used as distinguished from the depth of precipitation and irrigation applied in one season. This correction is made by determining moisture content of the soil to a depth of 6 ft. at the beginning and the end of the plowing season. An interesting discussion took place at the close led by John Haddin.

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WATER WORKS PROGRESS

THERE is strong probability that the 42nd annual meeting of the American Water Works Association, which will be held next week at Philadelphia, will be attended by the largest aggregation in history of sanitary experts dealing with the purification of water supplies. The program has been prepared to include papers upon every branch of sanitary engineering.

Every municipality and water company should make an effort to be represented at this meeting. At these gatherings the discussions and exchange of opinion upon the numerous problems encountered, has frequently resulted in increased efficiency and economy in plant operation and maintenance.

During the past twenty years rapid advances have been made in water purification, the economic value of which is seldom fully realized by the general public. A few years ago the quality of water in several large cities in the United States and Canada was regarded as so unsatisfactory that tourists, when coming from Europe, were often advised not to go to certain cities, or, if they did, not to drink the water unless it were boiled. The advent of filtration and sterilization, with a subsequent decline amounting almost to elimination of typhoid fever, has completely altered these conditions—so much so that Prof. Winslow, when speaking recently before the American Society of Civil Engineers, stated that "there is glory enough for all in the fact that at last typhoid statistics of the United States can be compared with those in Europe without the sensation of humiliation."

One condition that must be regarded as highly unsatisfactory, and which exists throughout the American continent, is the reckless discharge of untreated sewage into rivers and streams from which public supplies are drawn. Many state and provincial laws exist prohibiting this practice, but no attempt is made to enforce such acts; consequently it must be assumed that those responsible for enforcing the observance of the law are in sympathy with the offending parties or else feel that they are powerless to uphold the law.

The practice of sewage disposal by dilution in rivers and lakes is supported by many engineers who claim it to be more practical and economical than the purification, by artificial means, of both sewage and water supply, the purification of the latter being regarded as a basic and essential condition.

When the water supply is not polluted by the industrial wastes which are said to combine with the chlorine used for the sterilization of water, producing tastes and odors, such practice may be permissible, but it can surely never be regarded as satisfactory.

The technical papers to be presented at Philadelphia include able discussions of many problems recently encountered in operation, and special attention is being given to the prevention of tastes and odors in treated waters. In connection with this particular problem, many of our Canadian municipalities would do well to investigate this subject and to try to eradicate the offensive tastes which periodically develop. From the valuable article by Norman J. Howard which appears in this issue, it will be seen that the city of Toronto has undertaken exhaustive and seemingly effective research. In the "Fourth Report on Progress of Applied Science During 1919," the work carried out in the Toronto laboratory received special mention, testifying to the efficiency of the laboratory and to the enterprise of the city of Toronto in maintaining it. The remarkable decline in typhoid fever in Toronto is further proof of the efficiency of water purification.

MEETING THE FIRE WASTE

RECENT statistics indicate that the appalling loss of property and life through fire continues both in Canada and the United States. In 1921 the fire loss of Ontario was \$13,819,953 or more than two million dollars in excess of that for 1920. There were in all 9,698 fires, or an increase of 392 for the year. For the whole of Canada the fire loss for 1921 was \$45,015,930 and the per capita loss was \$5.22, as compared with \$3.24 in 1920. For the same year the loss in Great Britain was \$36,400,000. In the last fifty years the total cost to Canada of fires, the upkeep of fire-fighting apparatus and the excess of fire insurance premiums over claims has been over \$700,000,000. This does not include the loss from forest fires, which has been variously estimated as from eight to fifteen million dollars annually.

The National Board of Fire Underwriters in summarizing recently the fire loss situation in the United States, points out that there has been a loss of property in that country through fire, averaging \$334,000,000 annually for the five years from 1916 to 1920. The regrettable part of this finding is that in the opinion of the Board no less than \$856,000,000, or 67% of the aggregate loss for the five-year period, was strictly or partly preventable.

Fire prevention officials in Canada estimate that quite as large a percentage of the fire loss as that named above is preventable in Canada. The loss for 1921 in Ontario is said to have been 80% preventable. When it is considered that many thousands of people are rendered homeless by the widespread carelessness with respect to fire and that the shortage of dwellings is thereby increased, the necessity for action is obvious. If there be added to this loss the incalculable value of the loss of several hundred human lives in the last five years, the argument for concerted and vigorous action is irresistible.

PERSONALS

J. C. GARDNER, of Niagara Falls, Ont., has been appointed road engineer for Welland County.

WALTER J. FRANCIS, consulting engineer of Montreal, has been appointed engineer to the Ontario Hydro-Electric Inquiry Commission.

JAMES A. BELL, of St. Thomas, Ont., engineer for Elgin County, has returned home after a three months' vacation at Biloxi, Miss., and other points along the Gulf of Mexico.

GABRIEL HENRY, chief inspector of the Ontario Provincial Roads Department, has been appointed superintendent of the service of maintenance and improvement of roads.

LIEUT.-COL. H. C. BOYDEN, a member of the engineering staff of the Portland Cement Association, has completed a lecture tour of Canada. Col. Boyden visited the West, and while in the East, lectured at Montreal and Ottawa.

A. W. SWAN, assistant general secretary of the Engineering Institute of Canada, Montreal, has resigned and has sailed for England, where he intends to reside permanently. Mr. Swan came from England several years ago, and after a course at the University of Toronto he entered the employ of the Canadian Ingersoll-Rand Co., at Sherbrooke, Que. He left that position in 1918 to assume charge of editorial work on the Transactions and Journal of the Institute.

GEORGE HOGARTH, who was elected president of the Association of Ontario Land Surveyors at the last annual meeting, is a native of the Province of Ontario and a graduate of the University of Toronto, class of 1909. After a brief experience in railway work, Mr. Hogarth joined the staff of the Ontario Department of Public Works in 1910 as assistant engineer, and for the following six years he was engaged in design and construction work on the Magnetawan Lock, the Winnipeg River Bridge and other important undertakings of the Department. In 1916 he was promoted to the position of chief engineer of the Ontario Department of Public Highways, which position he now holds. Much of the excellent highway construction and maintenance throughout Ontario during the past six years has been due to Mr. Hogarth.

OBITUARIES

GEORGE P. STIRLING, retired contractor, died in Winnipeg, recently, aged 82. Mr. Stirling was born in Galashiels, Scotland, and settled in Winnipeg 50 years ago where he ultimately became a building contractor and constructed a number of important buildings.

WILLIAM AINLAY, contractor, died at his home in Toronto, on April 26, aged 75. The deceased originally came from Brussels, Ont., but had been residing in Toronto about 18 years.

MAJOR HAROLD J. MACKENZIE, of Woodstock, Ont., died at St. Michael's Hospital, Toronto, on April 25.

Major Mackenzie was born at Woodstock 30 years ago and graduated with honors from the School of Practical Science, Toronto, in 1914, as a mining engineer. At the outbreak of war he was connected with the Phelps Dodge Corporation, New York, City, but left this concern in 1915 to enlist in the Canadian Engineers, later transferring to the Royal Engineers.

FREDERICK G. TWITCHELL died in Hamilton recently. The deceased was engaged in road construction work most of his life in Arizona and Mexico, and resided in Hamilton for a few years, during which time he was employed in the construction of the Brantford & Hamilton electric line. He served with the American forces in France during the war, where he contracted scarlet fever, from the effects of which he never fully recovered.

Letter to the Editor

LIBRARIES FOR RESEARCH WORKERS

Sir:—The letter of A. S. L. Barnes in your issue of March 7, page 294, brings before us some very important, interesting suggestions. He proposes that a combined catalogue be prepared and kept at some central location accessible to all, comprising all the technical and scientific books and magazines that are located in the various public and private libraries in Toronto; and, if possible, a copy of this index in each individual library.

I am heartily in favor of this suggestion together with the other suggestions of Mr. Barnes. Some co-operation exists now between some of our private libraries, but not nearly as much as should be. With a co-operative plan in operation it would save expense and duplication of books. But the greatest benefit would be the saving of time in research and investigation. Usually, when we want information, it must be produced quickly within a few hours, or it is of no use. There is also a great advantage in being able to get the advice and help of a number of librarians and statisticians in working on the same problem to produce results quickly; this method is being carried out now to some extent in Toronto.

Dr. Locke and his associates in the Toronto Public Library have had plans prepared for a long time for an Applied Science Reference Department, and have been waiting for an extension to the College Street building to carry out these plans.

I believe the Toronto Public Reference Library is the logical place to have the "co-operative catalog" of technical and scientific books, and magazines of all the libraries in the city. The library staff are willing to help us if we help them. Someone should call a meeting of representatives of the private libraries in the city to meet with Dr. Locke to work out a co-operative scheme and to start something on a small scale at first.

I am also glad to see the letter of G. W. Lee, Librarian, Stone and Webster, Inc. in your issue of March 28, page 355, on this subject. We thank him heartily for his suggestions and co-operation.

I hope to see this movement under way as soon as possible, and shall be pleased to help in any way.

Yours truly,

HERBERT C. POWELL,

Statistician, Toronto Hydro-Electric System.
Toronto, April 29, 1922.

Before the Ottawa branch of the Engineering Institute of Canada recently, H. G. Acres, hydraulic engineer for the Hydro-Electric Power Commission of Ontario, gave an interesting address on the construction of the Chippawa-Queenston canal and power plant at Queenston. The lecture was illustrated by means of lantern slides and motion pictures. K. M. Cameron, chairman of the Ottawa branch presided.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

	Tenders	
Place of Work	Close	Issue
Ontario, Province of, supply of road oil	May 10	May 2
Hamilton, Ont., construction of sewer ..	May 22	May 2
West St. Paul R.M., Man., drilling of two wells	May 10	May 2
Edmonton, Alta., supply of regulators and transformers	May 15	May 2
Ottawa, Ont., supply of fibre conduit, "T" beams and cast iron manhole covers	May 12	May 2
Lethbridge, Alta., furnishing 13 cast iron gates	May 16	May 2
Fredericton, N.B., erection of Christ Church Cathedral Hall and Sunday School ..	May 25	May 2
Dresden, Ont., construction of concrete pavements	May 16	May 2
New Brunswick, Province of, gravel roads	May 16	May 2
Ontario, Province of, work on Provincial highways	June 2	May 2
Saskatchewan, Province of, construction of earth road from Bienfait to Estevan	May 17	May 2
Saskatchewan, Province of, construction of an earth road from Fairlight to the Manitoba Boundary	May 17	May 2
Wingham, Ont., construction of concrete pavements	May 11	May 2
Queenston Heights, Ont., sub-grading and construction of macadam roadway	May 24	Apr. 18
Toronto, Ont., construction of Gerrard St. bridge	May 16	Apr. 18
Montreal, Que., erection of Notre Dame Hospital	May 15	Apr. 23
Ford City, Ont., erection of school ..	May 10	Apr. 25
Newmarket, Ont., erection of arena building	May 10	Apr. 25
P. E. I., Province of, grading and concrete structures	May 19	Apr. 25
Quebec, Province of, road construction	May 12	Apr. 25
Winnipeg, Man., three 1000 k.v.a. transformers	May 15	Apr. 25
York Tp., Ont., concrete culverts	May 13	Apr. 25

BRIDGES, ROADS AND STREETS

Arthur, Tp., Ont.—Tenders will be received by Albert Hellyer, Township Clerk, Kenilworth, Ont., until 1.30 p. m., Tuesday, May 16, for the construction of three flat top concrete bridges. Specifications may be seen at the clerk's office.

Aurora, Ont.—Residents along Yonge St. have decided to urge the Provincial Government to widen Yonge St. to 100 feet.

Beamsville, Ont.—Highway construction under the Provincial department will start again about the 15th of the month. This means repairs and new construction all the way between Hamilton and Niagara and will include the main streets of Beamsville and Grimsby.

Blenheim Tp., Ont.—Tenders close May 10 for the construction of two concrete abutments and the erection of a steel bridge with concrete floor over Smith's Creek. Separate tenders for the concrete and the steel. Township Clerk, Hugh Allan, Drumbo, Ont.

Brockville, Ont.—Works Committee plans to repair a number of streets, including Brock St. west and Lewis St. Committee will look into a suggestion made by Ald. F. W. Logan that the town purchase a street-construction plant at an approximate cost of \$30,000. Chairman, George W. Warwick.

Burlington, Ont.—A by-law on the proposed paving of Brant St. will be submitted to the ratepayers. Clerk, L. Sykes, Burlington.

Calgary, Alta.—City Engineer Craig's department has \$25,000 at its disposal as the third instalment of the \$75,000 road graveling bylaw, which has now been two-thirds expended.

Chatham, Ont.—Tenders will be received by L. A. Pardo, Kent County Road Superintendent, Chatham, until 4 o'clock p.m., Monday, May 15, for the construction of about 1½ miles of concrete pavement in the suburban area adjoining the city of Chatham. Plans and specifications may be seen at the office of W. G. McGeorge, C.E., Chatham.

Chatham, Ont.—Tenders will be received by L. A. Pardo, Road Superintendent of Kent County, until noon, May 17, for the construction of about 7¼ miles of concrete pavement, 1¼ miles near Thamesville and 5½ miles between Wallaceburg and Dresden. Plans and specifications may be seen at the office of W. G. McGeorge, C.E., Chatham.

Cobourg, Ont.—Town Council decided to pave King St., from the eastern town limits to William St., at an estimated cost of \$127,000. Clerk, Ben Ewing.

Dundas, Ont.—Fire completely destroyed the new loading viaduct of the Canada Crushed Stone Co. causing a loss of about \$340,000.

Edmonton, Alta.—Temporary improvements to the south approach of the high-level bridge will be undertaken shortly by the city and provincial authorities. Estimated cost, \$7,000. Construction of a new west side approach has been endorsed. City Clerk, C. E. K. Cox.

Fredericton, N.B.—Province of New Brunswick is selling an issue of debentures amounting to \$500,000 for permanent bridges.

Fredericton, N.B.—Plans and estimates will be prepared for City Council on proposed extension of Aberdeen St. through York St. to University Ave.

Hamilton, Ont.—City Engineer E. R. Gray has advocated the paving of King St., from Sherman Ave. to the Delta.

Hespeler, Ont.—Town Council passed a resolution providing for the borrowing of \$2,477.32 for sidewalks. Clerk, M. E. Jardine.

Hespeler, Ont.—Town Council passed by-law authorizing construction of concrete sidewalk on east side of Kribs St. Clerk, M. E. Jardine.

London, Ont.—Improvements to certain highways leading out of the city have been recommended to the Town Planning Commission by Thomas Adams, Town Planning Expert, of Ottawa.

London, Ont.—City Council intends to construct sheet asphalt pavement on Wharncliffe Road, from Dundas St. to Oxford St.; Dundas St., from Wharncliffe Road to River Thames; Oxford St., from Wharncliffe Road to the River Thames; and on Talbot St., from Oxford St. to Carling's Creek. Total estimated cost, \$60,452.46. City Engineer, H. A. Brazier.

Longueuil, Que.—Council voted \$150,000 for construction of pavement, work to be done by day labor by city.

Malden Tp. Ont.—Bulk or separate tenders, addressed to Howard Gibb, Township Clerk, R. R. No. 2, Amherstburg, Ont., will be received until noon Monday, May 15, for the construction of a steel bridge 50 ft. span, abutments and grading over Big Creek. Plans and specifications may be seen at the office of the township clerk, or at the office of Lennox T. Bray, C. E., Amherstburg.

Montreal, Que.—City officials plan to open up Sherbrooke St. to the eastern limits of the city.

Montreal, Que.—Tenders close May 10 for the supply of 100,000 granite blocks, 150,000 gallons of bituminous dust layer and 40,000 tons of sand. City Clerk, Rene Bauset.

Nelson, B.C.—Ratepayers passed bylaw providing for an expenditure of \$60,000 on street improvements this year. City Clerk, W. E. Wasson.

Nelson, B.C.—Tenders will be called to close May 15 for the construction of 46 blocks of macadam. Mayor C. F. McHardy.

Nelson, B.C.—City Engineer has been authorized to proceed at once with the improvement of Water St., Ward St., Shatham St. and Victoria St.

Newmarket, Ont.—Tenders close May 10 for the paving of certain streets with either stone filled sheet asphalt, Warrentite-Bitolithic, concrete or macadam, approximately 12,000 sq. yds. Consulting Engineers, James, Proctor and Redfern, Ltd., Toronto.

New Toronto, Ont.—New Toronto will seek immediate co-operation with ratepayers of Long Branch, and Etobicoke Township and Mimico councils toward bringing before the Ontario Government the matter of the widening of the Toronto-Hamilton Highway.

North Bay, Ont.—City Council authorized Wm. N. Snyder, Town Clerk, to obtain prices on road oil.

North Bay, Ont.—Town Council authorized the Board of Works to purchase a ten-ton road roller. Clerk, Wm. N. Snyder.

North Oxford Tp., Ont.—Tenders, addressed to Richard Seldon, Clerk, Ingersoll, will be received until Saturday, May 27, for the construction of concrete abutments for bridge; also tenders for the building of grade to the bridge. Plans and specifications may be seen at residence of Reeve, Herbert Baigent, North Oxford, or at the Clerk's office, Oxford St., Ingersoll.

Oshawa, Ont.—A report recommending construction of pavements on Front St. and Centre St. was referred to the Board of Works.

Ottawa, Ont.—Tenders close May 9 for the supply and delivery of coarse sand. Commissioner of Works, A. F. Macallum.

Ottawa, Ont.—Contract for wood block pavement on Rideau St., from Sussex St. to MacKenzie Ave., awarded to O'Leary's, Ltd., at \$14,702.50; for asphalt pavement on Armstrong St., from Bayview to Garland, to the Standard Paving Co., at \$7,585.75; and from Parkdale to Holland, to the City Engineer at \$10,120.

Ottawa, Ont.—Hector Carruthers, secretary of the Ottawa Board of Trade, visited the council meetings of West Hull and Wakefield recently. At Wakefield the council undertook to keep that portion of the Ottawa-Wakefield road lying in the village of Wakefield, in repair if the Quebec government would rebuild the road. As South Hull and West Hull have already agreed to keep their portion in repair under similar conditions, that means the entire road is arranged with the exception of a stretch in Wakefield township between the village of Wakefield and the line of West Hull, a distance of probably three quarters of a mile.

Owen Sound, Ont.—City Council let contract to Dewar Bros. to crush and deliver stone on roads as required, at \$1.90 per yard.

Owen Sound, Ont.—Board of Works' Improvement program includes the paving of 6th St. and improvements to a number of other roads.

Peterboro, Ont.—Tenders close at 4 p.m., Wednesday, May 10, for approximately 7,000 sq. yds. of concrete pavement on George St. City Engineer, R. H. Parsons.

Point Grey, B.C.—Tenders for the construction of concrete sidewalks were received until May 2. Clerk, Henry Floyd, Municipal Hall, Kerrisdale, B.C.

Port Arthur, Ont.—Work on the construction of the automobile highway from Port Arthur to Nipigon is about to be resumed. The bridge over the McKenzie River is to be repaired and a new bridge will be installed over one of the big gullies near Sibley.

Portsmouth, Ont.—Council decided to repair Main St. Clerk, James Scally.

St. Lambert, Que.—Tenders will be received until 5 p.m., Monday, May 15, for asphalt pavement. City Engineer, E. Drinkwater. (See official adv.).

St. Lambert, Que.—A grant of \$20,000 for paving the Riverside Drive, to form part of the proposed St. Lambert-Levis riverfront highway, has been made to the city of St. Lambert by the Provincial Government. The City will call for tenders for the asphalt paving of the drive in the near future.

St. Thomas, Ont.—City Council let contract to the Standard Paving Co., of Ottawa, for the asphalt pavement work to be undertaken this year. Contract is for both the laying of the asphalt surface at \$1.98½ per sq. yd., and the excavating and construction of the concrete base, at \$1.49 per sq. yd. Contract for construction of curbs and gutters and also for concrete sidewalks was awarded to William Irwin & Son. The price for sidewalks is 22c. per sq. ft.; for gutters, 60c. a ft.; and for curbs and gutters combined, 98c. a ft.

Saskatchewan, Province of.—Tenders will be received until 12 o'clock noon, Tuesday, May 23, for construction of earth roads from the northeast corner of Section 36, Township 33, Range 12, west of the 2nd meridian to Wadena; also from north of Watson to St. Gregor. H. S. Carpenter, Deputy Minister of Highways, Regina.

Simcoe, Ont.—Alternate tenders for concrete pavement or Tarvia macadam pavement for the County of Norfolk will be received until 6 o'clock p.m., May 13, addressed to Guy R. Marston, County Engineer, Simcoe. Plans and specifications may be seen at the County Engineer's office, Simcoe.

Stratford, Ont.—Board of Works recommended to City Council construction of sidewalk on east side of Birmingham St., from Easson St. to McFartane St.

Stratford, Ont.—City Council referred petitions for sidewalk on south side of Norfolk St. and pavement on McKenzie St. to Board of Works.

Stratford, Ont.—Board of Works recommended that pavement work be proceeded with on following streets: Perth, from Downie to Whitney; Front, from East Gore to Perth; McNab, from Grant to Whitelock; Grant, from Downie to Home; Home, from Grant to West Gore. Adopted by City Council.

Stratford, Ont.—City Council passed by-law authorizing construction of pavements on following streets: Erie, from St. Patrick to Ontario St.; St. Patrick, from Erie to Wellington; Huron, from Ontario to Douglas St.; Front, from Downie to Home St.; and Home, from Grant to West Gore St. City Engineer, A. B. Manson.

Stratford, Ont.—Work on the Provincial highway between here and Kitchener will be commenced in the near future. It is proposed to grade the road this year, and paving will possibly be done next year. Provincial Highway Department intends to construct a highway 86 ft. wide, or 10 ft. wider on either side than at present.

Stratford, Ont.—City Council intends to construct excavation, concrete base, concrete combined curbs and gutters and drainage, with bituminous surface, on the following streets: Erie, \$19,952.73; St. Patrick, \$5,556; Huron, \$18,326; Rebecca, \$12,904.60; and St. Patrick, \$5,426.95. City Clerk, W. H. Dorland.

Toronto, Ont.—City Council passed sidewalk debenture by-law for \$256,772.

Toronto, Ont.—City Council intends to construct concrete curbs on Bingham Ave. at a cost of \$1,620.

Toronto, Ont.—City Council authorized construction of lane between Roxton Road and Ossington Ave., south of College St.

Toronto, Ont.—Mount Pleasant Road Ratepayers' Association has asked the City Council to back up the transportation Commission in giving a service in the district by extending Mount Pleasant road pavement both north and south and finishing the road from Eglinton Ave. to Merton Street.

Toronto, Ont.—Hon. F. C. Biggs, Provincial Minister of Public Works, has introduced a bill in the Legislature to authorize the raising of from \$25,000,000 to \$30,000,000 for provincial good roads from motor vehicle fees. The purpose of the bill is to provide funds for expenditure during the next three years, sufficient to put the entire eighteen hundred miles of provincial highways in satisfactory condition for the close of traffic they are intended to carry.

Victoria, B.C.—By-law authorizing the borrowing of \$110,000 to complete the Johnson St. bridge will be submitted to the ratepayers.

Victoria, B.C.—Tenders received for the completion of the Johnson St. bridge were as follows: Canadian Bridge Co., \$213,500; J. Coughlan & Sons, \$237,100; Dominion Bridge Co., \$252,300. Contract awarded to Canadian Bridge Co.

Walkerville, Ont.—Following petitions for local improvements have been presented to the Town Council. Pavement in alley between Argyle and Monmouth roads, from Wyandotte to Niagara St.; pavement in alley between Walker and Monmouth roads, from Tuscarora to Niagara St.; pavement in alley west of Lincoln road, from Sandwich to Wyandotte Streets. Town Clerk, A. E. Cock.

Westmount, Que.—Council decided to construct asphalt on Avenue Road east of Mount Pleasant Ave.

Whitby, Ont.—Tenders will be received by D. J. Kean, Ontario County Road Superintendent and Engineer, County Buildings, Whitby, until noon, May 15, for the construction of several reinforced concrete culverts. Plans and specifications may be seen at the Engineer's office.

York Tp., Ont.—Tenders will be received by Frank Barber, Township Engineer, until 12 o'clock noon, Saturday, May 20, for concrete sidewalks. (See official adv.).

York Tp., Ont.—York Township Council received notice from the York County Highways Commission that Scarlett Road, from Lambton to Weston, and Weston Road, from Buttonwood Ave. to Weston, would be paved this summer.

WATER, SEWAGE AND REFUSE

Brockville, Ont.—Works Committee passed by-law providing for the construction of a sewer on Front Ave., between Park and Ormond Streets. Chairman, George W. Warwick.

Cowley, Alta.—Village council is issuing debentures to the extent of \$1,000 for improvements to water works system. Sec.-Treas., M. A. Murphy.

Elko, B.C.—East Kootenay Power Co., Ltd., has been formed to take over the B. C. and Alberta Power Co. The company is installing a plant on the Elko River near here, which will have a capacity of 20,000 h.p.

Fredericton, N.B.—City Council plans extension of water works system up Woodstock Road, at cost of \$25,000.

Ford City, Ont.—Further water main extensions are being ordered by the Town Council. Clerk, J. F. Foster.

Halifax, N.S.—City Works Committee approved award of contract to Gorman & Peckham for water main pipe from the corner of Quinpool road to the foot of Cogswell St., and for sewer on South St., from Queen St. west.

Leamington, Ont.—Town Council is calling for tenders for sewers in Clarke St. West, Foundry St. and Chestnut St. Clerk, R. M. Selkirk.

Levis, Que.—City Council has been notified by Hon. Athanasios David, Provincial Secretary, under whose depart-

ment is the Superior Council of Hygiene, to the effect that a filtration plant must be built immediately. Estimated approximate cost, \$545,000.

Montreal, Que.—The construction of a sewer on Nicolet St., between Masson St. and St. Joseph Boulevard has been recommended to the city council by the Executive Committee. The cost will be \$17,343. The committee has placed at the disposal of the superintendent of the aqueduct \$31,339.84 to defray the cost of laying water mains.

Nelson, B.C.—Plans are being prepared by the City Engineer for a sewer in Fairview.

Orillia, Ont.—By-law submitted to ratepayers on May 8 authorizing an expenditure of \$30,000 by Water, Light and Power Commission for water works extensions and improvements. Clerk, C. E. Grant, Orillia.

Ottawa, Ont.—City Council approved the decision of the Board of Control to have the excavation work for the addition to the overland pipe done by day labor. The amount involved is about \$20,000.

Petrolia, Ont.—Contract for steel reservoir awarded to Horton Steel Works, Bridgeburg, at \$14,200, and for foundation to Alfred Kirkpatrick, of Petrolia, at \$2,594. Contract for pump not yet awarded.

Port Credit, Ont.—It is expected that tenders for the new water works system, which, it is estimated, will cost \$110,000, will be called for within a few days. The plans, which the Town Council approved, will now go to the Provincial Board of Health.

Riverside, Ont.—Extensive laying of water mains has been started by the Walkerville Water Co. Secretary, Charles D. Brown.

St. Thomas, Ont.—No. 2 Committee of City Council recommended construction of a sanitary sewer in Hiawatha St. and under Fourth Ave., between Myrtle and Locust Sts.

Sault Ste. Marie, Ont.—Tenders addressed to the Mayor will be received by the City Clerk until 5 p.m., May 15, for the construction of sewers. (See official adv.).

Smith's Falls, Ont.—Dr. J. W. S. McCullough and Engineer F. A. Dallyn, from the Provincial Department of Public Health, addressed a public meeting in Smith's Falls recently, urging the speedy installation of a filtration plant in connection with the waterworks system.

Stratford, Ont.—City Council referred petitions for sanitary sewer on Whitelock St., from McNab St. to Mowat St., and for water main on Downie St., to Board of Works.

Stratford, Ont.—Public Utilities Commission let contract for two gasoline engines for the water works department from the Canadian Fairbanks Morse Co., Toronto, and for a venturi meter to the Goldie & McCulloch Co., Galt.

Thorold, Ont.—Tenders addressed to D. J. C. Munro, Town Clerk, will be received until 12 o'clock noon, May 13, for the construction of sewers. (See official adv.).

Thornbury, Ont.—Town Council is submitting a by-law to the people for a water works supply system, voting to take place on May 22. James, Proctor and Redfern, Ltd., of Toronto, are the engineers.

Todmorden, Ont.—A public meeting of the Ratepayers' Association will be held on May 9, when a sewage scheme for the eastern part of the township and the proposed viaduct from Todmorden to Leaside will be discussed. At a recent meeting President Amos Allpress outlined four sewerage schemes suggested by York Township Engineering Department that might be used in this district. The drainage system to the Don Valley northward was favored.

Toronto, Ont.—Contracts for laying and jointing of 6-in. water pipes in Armadale Ave. and Parkway Gardens, awarded to Ruselca Bros.

Toronto, Ont.—City Council intends to construct a sewer in Fairmount Crescent at a cost of \$3,700; also a water main in Hillhurst Boulevard, at cost of \$2,451.

Toronto, Ont.—Street Commissioner Wilson has recommended an expenditure of \$6,000 to rebuild one of the furnaces at the western incinerator, pending the construction of a modern garbage destructor.

Toronto, Ont.—Ontario Railway Board has sanctioned city by-laws to issue debentures to the amount of \$315,000

for water works purposes, \$200,000 being for intake repairs and \$102,000 for the Yonge St. main.

Toronto, Ont.—Time for receiving tenders for the installation of one four-million Imperial gallon centrifugal pump at the Island Pumping Station has been extended from Tuesday, May 16, to Tuesday, June 13.

Westmount, Que.—Council authorized construction of sewer on Thornhill Ave., between Sherbrooke and Cote St. Antoine Road.

Woodbridge, Ont.—Council has instructed James, Proctor & Redfern, Ltd., of Toronto, to submit plans to the Provincial Board of Health that the by-law for water works supply system may be published at once.

York Tp., Ont.—Tenders will be received at the office of Frank Barber, Township Engineer, Toronto, until 12 o'clock noon, Saturday, May 20, for the construction of cast iron water mains. (See official adv.).

LIGHT, HEAT AND POWER

Hanna, Alta.—Town Council decided to purchase electric lighting plant for \$10,000.

St. John, N.B.—Tenders will be received by the New Brunswick Electric Power Commission until 6 o'clock, Tuesday, May 16, for the construction of a transmission line from St. John to Moncton. The Commission will supply all material. Plans and specifications may be seen at the office of the Commission in St. John.

RAILWAYS

Petrolia, Ont.—An agreement has been entered into with the Grand Trunk Railway Co. for the construction of a spur line railroad from their tracks to the Peninsular Sugar Co. site here.

Windsor, Ont.—Contract for the new Canadian Pacific Railway freight sheds and team tracks on Janette Ave. has been awarded to the Haymon Construction Co., of London. Estimated cost, \$200,000.

FACTORIES AND LARGE BUILDINGS

Amherst, N.S.—Dominion Government voted \$5,000 for drill hall, grading, etc., here.

Blenheim, Ont.—P. T. K. Lee Plans erection of one-story building for theatre.

Bridgeburg, Ont.—Town Council accepted the plans of C. M. Borter, architect of Niagara Falls, Ont., for the proposed new Town Hall.

Calgary, Alta.—Representatives of the Calgary G. W. V. A., City Council and Alberta government recommended to the executive of the local G. W. V. A. that the general contract for the new building be awarded to Gauley and Vandenhoozen, for \$34,393, and contract for plumbing and heating to Snyder & Co., for \$7,680.

Calgary, Alta.—Following tenders for new central stores and laundry building at the General Hospital were opened by the city commissioners and forwarded to City Engineer Geo. W. Craig for tabulation: Lancaster and Poulsen, \$16,445; Forster Construction Co., \$15,885; W. H. Cawston, \$15,800; City Engineering Department, \$15,791; Gauley & Vandenhoozen, \$15,374; Baird Construction Co., \$14,995; F. W. McDougall Construction Co., \$13,240. These tenders do not include plumbing, heating, elevator and electric work.

Calgary, Alta.—Following tenders were opened on April 27 in the offices of Burrell & Basevi, architects, for the erection of the new memorial hall and club rooms of the Calgary Great War Veterans' Association; General contract—Gauley & Vandenhoozen, \$38,419 and \$37,822; Thomas Jamieson, \$40,950 and \$40,550; O. J. Hurst, \$39,972 and \$39,297; R. J. Burns, \$44,339 and \$43,830; C. W. Pettifer, \$38,500 and \$37,750; Watson & Abercrombie, \$39,614 and \$38,964; Baird Construction Co., \$39,200 and

\$38,700. The first price in each case is with stone cornice and stone coping, and the latter price with metal cornice and metal coping. Plumbing and heating—Snyder & Co., \$7,995; James Ballantyne, \$8,002; J. Rogers, \$8,700; Campbell & Hillier, \$9,035; Parkinson & Davidson, \$8,500. Contract not yet awarded.

Demaine, Sask.—Most of the business section of the village was recently destroyed by fire. Loss, \$40,000.

Dundas, Ont.—Town Council passed a by-law providing for raising of \$15,000 as a loan to Frederick Powell Thornton to assist in the construction of a factory.

Dundas, Ont.—Plans are being rushed for the immediate reconstruction of the part of the Canada Crushed Stone Corporation's plant which was recently destroyed by fire. Mr. Buckbee, of Chicago, the company's consulting engineer, is looking after the work.

Edmonton, Alta.—Contract for erection of Roman Catholic separate school awarded to H. J. Manson, the cost to be between \$45,000 and \$50,000.

Edmonton, N.B.—Dominion Government Department of Public Works considering the construction of a post office, customs building, etc., here.

Ford City, Ont.—Town School Board passed a resolution that immediate notice be sent to Architect A. H. McPhail to hurry up specifications and letting of tenders on the new \$100,000 Charlotte St. School.

Fort William, Ont.—Contract for erection of Crawford Ave. School awarded to John East Co., of Fort Frances, at \$71,183.16.

Halifax, N.S.—Provincial exhibition will be revived if the Commission is able to secure funds for the erection of buildings, which would cost approximately \$450,000. Address M. Mc. F. Hall.

Hamilton, Ont.—Bulk and separate tenders will be received by David Smith, Secretary, School Section No. 4, Ancaster and Barton, 77 Macnab St. north, Hamilton, until 4 p.m., Wednesday, May 17, for the different trades required for the erection of school building on Bowman St., West Hamilton. Plans and specifications on application to Warren & McDonnell, architects, Home Bank Bldg., Hamilton.

Kentville, Ont.—Contract for erection of King's County Poor House awarded to Denton & Condon.

Kitchener, Ont.—The Kitchener Orphanage Board have announced that plans are under way for the erection of a new building this summer. The institution will be outside the city limits on the Natchez Road, and will cost approximately \$70,000.

Leamington, Ont.—An addition to the High School is planned. Estimated cost, \$35,000, and \$5,000 for gymnasium. Tenders will be called. Address W. D. Cox.

Lethbridge, Alta.—Tenders were received until May 8 for alterations, additions and repairs to the Board of Trade building. Commissioner of Public Works, H. Wm. Meech.

London, Ont.—Plans of John R. Boyde, Architect, of Windsor, for three new Roman Catholic churches in London diocese, have been approved. Churches will be erected in North Chatham, Petite Cote and Leamington.

London, Ont.—That London should dispose of the Federal Square site on Dundas St. and with the proceeds purchase the deanery at Clarence and Queen's for the location of a new city hall and civic center, is one of the several tentative suggestions submitted by Thomas Adams to the Town Planning Commission.

Medicine Hat, Alta.—Fire caused an estimated loss of \$125,000 when the buildings and plant of the Medicine Hat Pump and Brass Manufacturing Co. were destroyed recently. The damage is covered by insurance to the extent of \$60,000.

Mimico, Ont.—Town Council passed by-law providing for the raising of \$65,000 for erection of new Public School. Clerk, C. J. Telfer.

Moncton, N. B.—Mann's Pasteurized Milk Factory, situated in Lewisville, was destroyed by fire recently. Loss, \$8,000; insurance \$4,000.

Moncton, N.B.—Plans for the erection of an 8-room school on Lester Ave. have been received by the Board of School Trustees. Trustees Fryers, Steeves and Sears were appointed a committee to consider same.

Montreal, Que.—Three new schools are being put in hand for the Protestant Board of School Commissioners, as well as one extension, the total estimated value of the four jobs being \$500,000. The Board will also provide school accommodation in the part of the territory of St. Laurent that lies within the city of Montreal (mainly Cartierville). The Catholic School Commission's program is nine new schools and three additions, at a cost of \$1,584,000.

Mount Elgin, Ont.—Tenders for the erection of a Continuation School will be received until May 15. Plans and specifications may be seen at office of F. H. Harris, Sec.-Treas., Mount Elgin.

Mountain, Ont.—B. Dillon, architect, is preparing plans for the erection of a consolidated school here to serve four rural school sections in Dundas county, which are to be amalgamated.

Nelson, B.C.—Contract for erection of Memorial Hall in connection with St. Saviour's Church has been awarded to W. Pascoe and the plumbing contract to Harry-Epenson. Stone construction. Total cost, \$14,000.

Ontario, Province of.—Dominion Government voted \$349,200 for public buildings in Ontario.

Oshawa, Ont.—Permit issued for rebuilding of the Thornton rubber factory for W. E. Phillips, Ltd. cost, \$20,000.

Oshawa, Ont.—Town Council granted the Board of Education \$200,000 for two new schools and repairs to existing public and high schools.

Ottawa, Ont.—Dominion Government voted \$38,000 for improvements and repairs to Dominion public buildings in the Maritime Provinces.

Ottawa, Ont.—Ottawa Auxiliary Bible Society plans erection of permanent Bible House on north side of Lisgar St. Vice-president, Rev. S. J. Farmer.

Ottawa, Ont.—Jewish people of this city will launch a campaign on May 15 to raise \$35,000 for the erection of a community centre building. Chairman of committee, Sam Bilsky.

Ottawa, Ont.—Dominion Government voted the following amounts for public buildings: British Columbia, \$59,519; Alberta, \$31,000; Saskatchewan, \$27,000; and Manitoba, \$40,500.

Ottawa, Ont.—An addition to cost \$20,000 is to be added to St. Matthew's Anglican church in the Glebe. Plans will be completed and tenders called for. Millson and Burgess are the architects.

Owen Sound, Ont.—Plans for the proposed addition to the Collegiate Institute were presented to the Board of Education by the architects, J. T. Clark, of this city, and McGiffin & Smith, Toronto. Board accepted plans.

Partridge Island, N.B.—Dominion Government voted \$35,000 for repairs and improvements to the St. John quarantine station here.

Peterboro, Ont.—Contract for re-roofing the Brinton Carpet Company's factory on Lock St. awarded to James Fennie.

Port Credit, Ont.—Permission granted by Town Council to Methodist Church members to proceed with the erection of a Sunday School and recreation hall, at a cost of \$22,000.

Port Dover, Ont.—A. C. Stewart and Sons have started work on the removal of the old foundations of the Tibbetts block preparatory to the erection of a building to be occupied by the post office and J. G. Patterson, druggist.

Quebec, Que.—The club house of the Quebec Golf Club at Montmorency Falls was destroyed by fire recently. Loss, \$20,000.

Quebec, Province of.—Provincial Government has decided to add a new wing to the Parliament Buildings which will be erected on St. Julia St. Estimated cost, \$700,000. Minister of Public Works, Hon. Antonin Gaillet.

Quebec, Que.—Following contracts awarded for erection of Immaculate Conception School: Masonry, Magloire Cauchon, \$58,086; plumbing, F. Gingras, \$9,953; painting and glazing, J. Tardivel, \$2,578.50; roofing and ventilation, Omer Barbeau, \$1,964.

St. George, N.B.—Dominion Government Department of Public Works considering the construction of a post office and customs house here.

Silverthorn, Ont.—Local branch G. W. V. A. will start work at once on addition to Memorial Hall. Cost, \$4,000. Address A. Hammond.

Stayner, Ont.—Tenders closed May 6 for the erection of an 8-roomed school building. Secretary, Jas. Peattie, Stayner.

Stratford, Ont.—Board of Education let contract for erection of a 4-roomed school to Pounder Bros., Stratford, for \$58,500.

Stratford, Ont.—By-law passed by City Council providing for the raising of \$50,000 for an addition to Hamlet Ward School. City Clerk, W. H. Dorland.

Sussex, N.B.—Dominion Government voted \$5,000 for improvements to public buildings here.

Swansea, Ont.—Members of Morningside Presbyterian Church plan erection of Sunday school building. Pastor, Rev. J. G. Cheyne.

Toronto, Ont.—Coca-Cola Co., 1621 Queen St. West, plans erection of new plant. Manager, George Porter.

Toronto, Ont.—Members of Greenwood Avenue Presbyterian Church plan erection of Sunday School building at corner of Gilebemoat and Greenwood Ave. at a cost of \$35,000.

Toronto, Ont.—H. Addison Johnston, managing director of Professional Officers, Ltd., asked the City Council to order the issuing of a permit for the physicians and surgeons building to be erected at 86 Bloor St. west held up on account of the widening project.

Toronto, Ont.—Board of Education will receive tenders until May 10 for the following work: (1) Masonry, structural steel, carpentry, plumbing, heating and ventilating, electric wiring, local phones, for Parkdale Collegiate and Roden School; (2) masonry, structural steel, carpentry, roofing and tinsmithing, plastering, painting and glazing, plumbing, heating and ventilating, electric wiring, local phones, for Norway School; and (3) electric wiring for Ogden School.

Vancouver, B.C.—Pacific Starch Products, Ltd., will build a plant in south Westminster, at a cost of \$40,000.

Wainstead, Ont.—Fire destroyed the G. T. R. station here.

Welland, Ont.—Contracts for the erection of the new main mill building of the Lackawanna Tubes' plant were let as follows: Foundation work, Jay C. Diffin; steel and erection of building, Standard Steel Construction Co.

Westmount, Que.—Plans for the proposed new City Hall will be considered at a special meeting of the Westmount City Council.

West Toronto, Ont.—A campaign to raise \$15,000 for the erection of a new church building has been launched by St. Paul's Anglican Church.

Whitely, Ont.—Contract for erection of four-room continuation school awarded to U. H. Peardon, Windsor, Ont.

Windsor, Ont.—Members of Bruce Ave. Baptist Church plan erection of new church building on Victoria Ave., south of Wyandotte St. Pastor, Rev. Owen C. Gray.

Windsor, Ont.—Plans are being prepared by Architects Pennington & Boyd, of this city, for the erection of a convent at Woodlee at a cost of \$10,000, and for Beech Grove Country clubhouse.

Windsor, Ont.—French Canadians of the Esser Border are contemplating the establishment of a school in this city. An organization known as the League Des Patriotes, of which Ernest Parent, Windsor, is president, has been formed to raise the necessary funds.

Winnipeg, Man.—Tenders close May 10 for concrete work (floors, etc.) to be carried out at the North End and

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

New Highway Bridge Over Batiscan River, Que.

Important Link Completed in Montreal — Quebec Highway — Six Fixed Spans of 189 ft. and 62-Ft. Bascule Span — Pile Foundations on Soft Clay — Great Care in Computing Counterbalancing—Easy Operation of Bascule

By EDWARD HOLGATE

Chief Engineer, MacKinnon Steel Co. Ltd., Sherbrooke, Que.

ON NOVEMBER 1, 1921, the new bridge at Batiscan, Que., about twenty miles east of Three Rivers, on the automobile road between Montreal and Quebec, was opened to regular traffic. Motorists in particular will rejoice that the delays of the old ferry are a thing of the past.

The bridge, shown in process of construction in Fig. 1, is 1211 ft. long with a concrete roadway 18 ft. wide between the steel wheel guards. There are six main spans, each 189 ft. centre to centre, and one bascule span 62 ft., centre to centre. The structure was designed for the following live loads: (a) A uniformly distributed load of 100 lb. per sq. ft. of road for floor system and directly affected truss members, and 83 lb. per sq. ft. for truss chords and main diagonals; (b) an alternative moving concentrated load of 15 tons distributed as ten tons and five tons on each of two axles 10 ft. apart. On members determined by the latter, an impact of 30% of the live load was added. Unit stresses were in accordance with the requirements of the Department of Public Works and Labor, Quebec, which practically conform to the specifications of the E.I.C.

Foundations

While the present article deals chiefly with the superstructure, some remarks will first be made concerning the foundations. The six concrete piers stand on soft blue clay which extends to a depth of over 90 ft. with practically no change in character. The spread of the concrete bases is arranged to give a maximum pressure of $2\frac{1}{4}$ tons per sq. ft. The concrete piers were started about 7 to 12 ft. be-

larger than the others. Its base is 25 by 45 ft. and rests on 166 wooden piles enclosed by steel sheet piling. The lengths of the interior piles are arranged so that their lower ends form a dome with its apex at the centre of the pier, an expedient which probably induces an arch action in the clay. When building the superstructure over this pier, it was found that the addition of 300 tons of dead load produced no settlement that could be detected by the ordinary levelling instruments, and it is safe to say that, if any such occurred, it was less than $\frac{1}{4}$ in.

Main Spans

The six main spans are alike and have trusses of Baltimore type with top chords cambered about three feet. The latter effected a slight economy in material and improved the appearance of the bridge, especially when seen as foreshortened. The end floorbeams are designed to enable each span to be jacked up from the pier, a clearance for jacks being provided by standing the trusses on concrete pedestals about 20 in. high. Expansion joints on alternate piers are arranged as shown in Fig. 2. These spans were erected on falsework, placing floor systems and bottom chords first and erecting upper chords and web members when returning with the traveller.

Bascule Span

The bascule span was designed by the Strauss Bascule Bridge Co., and is noteworthy for its simplicity and neat appearance. The counterweight is unobtrusive and is



FIG. 1.—BATISCAN BRIDGE UNDER CONSTRUCTION.

low the bed of the river within an enclosure of Lackawanna steel sheet piling extending down about 27 ft. farther. Inside this enclosure wooden piles were driven to a depth of about 45 ft. below the sheet piling, and many of them were provided with friction vanes nailed thereto consisting of 4 by 5 in. wood pieces about 12 ft. long. Pier 5, on which rest the bascule and adjacent span carries a total load, exclusive of its own weight, of about 450 tons and is

probably not noticed by most passengers over the bridge, as it aligns with the portal and sway bracing of the adjacent spans. The bridge consists of two half-through plate girders of peculiar shape connected by five floorbeams consisting of 24 in. 1 beams, 23 ft. 10 in. long which carry seven lines of 9 in. beam stringers. Over these are laid a 4 in. creosoted pine floor and $1\frac{1}{2}$ in. wearing floor of the same material with 4 by 6 in. timber wheel guards pro-

viding a road 18 ft. wide. The bridge can be opened by hand power in seven minutes or by the gasoline engine in $1\frac{1}{2}$ minutes.

Counterweight

Much of the success which attended the erection and operation of the bascule bridge was due to the great care

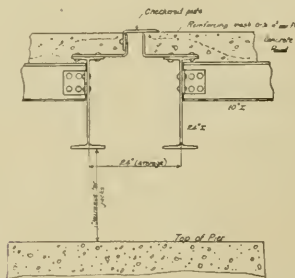


FIG. 2—EXPANSION JOINT IN ROADWAY BETWEEN END FLOORBEAMS OF ADJACENT SPANS

taken in calculating the weight and centre of gravity of the moving parts and in determining the weight and dimensions of the concrete counterweight. The weights of the individual parts of the moving bridge were taken from the shop drawings and their moments figured about two rectangular axes through the centre of the main trunnion. The wooden flooring formed a large proportion of this moment and it was therefore decided to carefully weigh many samples of the wood. Eleven samples of 4-in. plank, creosoted, varied in weight from 4.32 lb. to 5.83 lb. per ft. B.M., with an average of 4.83 lb. Six samples of 6-in. timber, creosoted, weighed from 4.21 to 4.58 lb. per ft. B.M., averaging 4.35 lb. Eight samples of $1\frac{1}{2}$ -in. plank, creosoted, varied between 4.07 and 6.34 lb. per ft. B.M., averaging 5.11 lb. These figures indicate much variation, but the averages suggest that the thinner plank received a greater penetration of creosote. In building the counterweight, the forms were very carefully made, and owing to

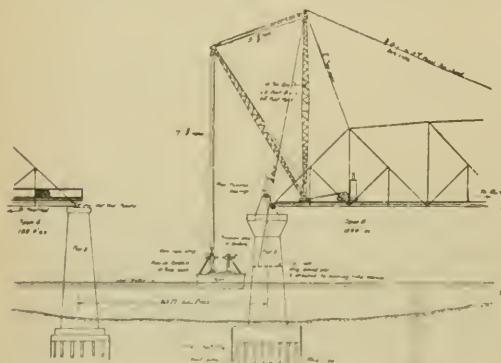


FIG. 3—FIRST STAGE OF ERECTION OF BASCULE SPAN — MAIN GIRDERS BEING RAISED TO HORIZONTAL POSITION ACROSS SHIP CHANNEL

cold weather, a rich concrete mixture, 1:2:4 was used. A sample of concrete as poured weighed $146\frac{1}{2}$ lb. per cu. ft. when 3 days old, and $145\frac{1}{2}$ lb. after the forms had been removed a week. In dimensioning the counterweight, it was arranged to have its centre of gravity almost coincident

with the vertical through the rear trunnion pin, but enough outside to keep the upper link always in tension.

Erection of Bascule Span

In erecting the bascule span, the four pedestals supporting the trunnion bearings were first set in line by transit on pier No. 4 and by steel tape across the ship channel. Great care was taken to set the tops of these pedestals in true line and level. No shim plates were used but precision was obtained by wedging under the shoes and grouting thereto after the milled plates on top were exactly in position. The bearings were then placed and the holes connecting them to the pedestals were drilled. Figures 3, 4 and 5 show stages in erecting the bridge. At seven o'clock one morning the two girders, each weighing 10 tons, were brought alongside pier 5 on a scow. Owing to their irregular shape and to economize time and lessen the risk, the position of the centre of gravity of each girder had been calculated and marked thereon and wire rope slings attached before the scow left the river bank. Hence, it took but a very short time to raise the girders and place them horizontally across the ship channel resting on the trunnion bearings at one end and on pedestals over pier 4 at the other. Four of the floorbeams with bracing were then inserted and the derrick fall was attached to the outermost floorbeam. At 4 p.m. the bridge was opened to practically its highest position, leaving the ship channel clear, and it was guyed to span 5. The remainder of the steelwork was then erect-

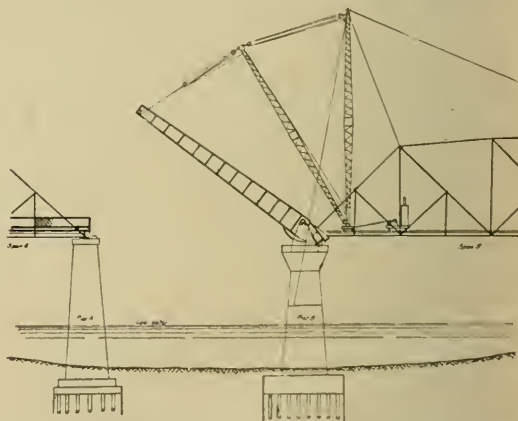


FIG. 4—SECOND STAGE OF ERECTION OF BASCULE SPAN — RAISING GIRDERS, FLOORBEAMS AND LATERAL BRACING TO CLEAR SHIP CHANNEL

ed by the derrick and the wooden floor laid. The 160 tons of concrete for the counterweight was deposited by bucket lifted by scow-derrick alongside the pier. Five days after pouring the concrete, the shoring under the counterweight forms was knocked out and the bridge found to be in exact balance without further adjustment. It was lowered straight to clear-road position by the hand lever and was ready for traffic. Then followed the erection of operator's house, safety gates and gasoline engine equipment.

Bascule Machinery and Accessories

The hand winch operates through four series of reduction gears to the pinions engaging the racks attached to the main girders. Gears are cast steel with machine cut teeth. One man could move the bridge without difficulty from the moment the counterweight was released. A 20-h.p. Gray motor, 4-cylinder, 4-cycle, operates a reversible transmission gear with clutches as an alternative to the hand movement. When in the lower position the bridge is locked to

the pedestal on pier 4 and these locks are withdrawn by a lever near the trunnion pin. The lever, however, cannot be moved until an adjacent handle is turned to close the gate across the road beyond pier 4.

The bridge was built under the supervision of Ivan E. Vallee, Chief Engineer of the Department of Public Works

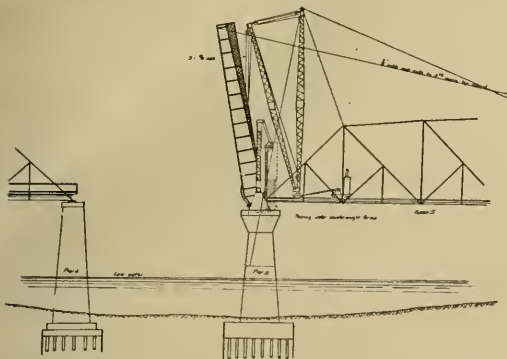


FIG. 5—THIRD STAGE OF ERECTION OF BASCULE SPAN — COMPLETING STEELWORK, FLOOR AND COUNTERWEIGHT WHILE BRIDGE IS GUYED BACK TO SPAN 5

and Labor, Quebec. Joseph Gosselin, Ltd., Levis, Que., built the substructure and concrete floor. The steel supererected by the MacKinnon Steel Co., Ltd., of Sherbrooke, structure, including bascule machinery, was furnished and Que.

LONDON BRIDGE WORKS NEW PLANT

GROUND has just been broken for the new plant of the London Bridge Works, Ltd., London, Ont., which will be of modern steel fireproof construction throughout and equipped with the latest machinery for the production of steel structures of all kinds, chiefly bridges and buildings. The plant will be built on an improved factory site formerly owned by the Dominion Cannery, Ltd., located just off Dundas Road on the Grand Trunk Railway, consisting of about three acres, which will give ample space for the time being.

In conjunction with the regular business of fabricating steel, an extensive warehouse will be built and equipped for the distribution of iron and steel products of all kinds, including steel plates, structural shapes, iron and steel bars, black and galvanized sheets etc. The plant and warehouse, when completed, about June first, will fill a long felt want in that part of the Province and will be much appreciated by builders and contractors in the district.

The company is incorporated under the Ontario Companies' Act with \$100,000 capital, the officers and directors being as follows: President, T. J. Dillon, Welland, Ont., President Standard Steel Construction Co.; Vice-President, Geo. M. Reid, London, Ont.; Directors, Philip Pocock, London, Ont., E. S. Little, London, Ont., Col. I. Leonard, London, Ont., C. J. Madgett, Welland, Ont., H. C. Baker, Welland, Ont. C. J. Madgett, formerly assistant general manager of the Standard Steel Construction Co., of Welland, will be the general manager.

GOOD ROADS ASSOCIATION MEET AT VICTORIA.

AMONG the speakers who have already accepted invitations to present papers for discussion at the Convention of the Canadian Good Roads Association at Victoria, B.C., on June 12-15 are the following: M. A. Lyons,

chief engineer of Roads Board, Province of Manitoba; C. W. Dill, superintendent of Highways, province of Saskatchewan; A. W. Campbell, Commissioner of Highways for the Dominion Government; J. D. Robertson, Deputy Minister of Public Works, Alberta; A. H. Hearst, State Highway Engineer of Wisconsin; B. M. Hill, chief engineer of Highways, Province of New Brunswick; J. A. Duchastel, city manager and engineer, Outremont, P.Q.; James Allen, Supervisor of State Highways, Olympia, Wash.; F. L. McPherson, superintendent of Public Works, Victoria, B.C.; W. A. McLean, deputy minister of Highways, Ontario; F. L. Fellows, city engineer of Vancouver, B.C.; H. S. Carpenter, deputy minister of Highways, Saskatchewan; A. S. McMillan, superintendent of Highways, Nova Scotia, and N. D. Darlington, chairman of the California Highways Commission.

This is not by any means the full list of the speakers who will deal with the road matters, from the financial, legislative and practical standpoint, including foundations, drainage, wearing surfaces, bridges, culverts and so on. Of special interest to Government officials who have to tackle the problem of highway maintenance in relation to modern automobile traffic, will be an address on motor trucks, maximum weight, width, loads, etc. by a representative of the National Automobile Chamber of Commerce, New York, while among the popular lectures will be one by H. D. Cuthbert, of the North West Pacific Tourist Association, whose address at the Winnipeg Convention was so much appreciated. Of particular interest to the prairie province delegates will be a lecture and demonstration by K. A. Clark, one of the research engineers of the Scientific and Industrial Research Council of Alberta, who has been making experiments in improving and maintaining prairie roads, and a method of getting bitumen absorbed on to the clay elements in soils to modify its action towards water.

The annual general meeting of the Canadian Good Roads Association will take place on the afternoon of Tuesday, June 13, when the annual report and financial statement will be presented and the officers and executive elected. The banquet will be on the Wednesday evening at the Empress Hotel. The Canadian Automobile Association will hold their annual meeting and dinner at noon on Wednesday, June 14, at which delegates from all the motor leagues in Canada will be present, the invitations having been sent out by W. G. Robertson, the secretary of the national association with which all the provincial motor leagues are affiliated.

ENGINEERS ADVOCATE NATIONAL DEPT. OF PUBLIC WORKS.

ENGINEERS started many years ago to urge the creation of a National Department of Public Works says a L. W. Wallace executive secretary of the Federated American Engineering Societies in a statement issued recently. Their sole reason was that the country needed, and still needs, the orderly functioning of its public works activities—needs it because our present system involves a huge waste of public funds, high taxes, and retarded public improvements. The principle is self-evident and if the proposed reform were merely an abstract principle there would be no one to dispute its merit.

The public works movement has been so successful that the matter has become a national issue, and it has been recognized generally that the principles underlying that movement should control in other functions of government. The Federated American Engineering Societies has become officially concerned with the creation of a Department of Public Works. It is apparent that the object can never be achieved unless the broader object is carried through successfully; therefore this organization, as well as all others which believe in efficient procedure and who know and understand the underlying principles, must participate in the entire program of government reorganization.

ESTABLISHING OF PLANT BASE LINES AS AN AID TO THE ENGINEER

Developing Base Lines in Industrial Plants — Locating Line and Placing Monuments — Design of Concrete Monuments

By J. LeRoy Underhill

IT HAS always appeared to the writer that the necessity of establishing permanent base lines, as a locus standi for engineering work in plants, has been greatly underestimated. In a great number of plants no permanent reference line is found and in many it is only vaguely located. This is more true of the older than of modern plants. More care and forethought is given to modern layouts and the principle of working from a fixed base is becoming more apparent.

Being engaged in one of the large Canadian steel plants where the lack of reference lines is a serious drawback, the writer has been watching with considerable interest the development of a type of permanent base line which is adaptable to any industrial plant.

Important Factors When Fixing Line

In fixing such a line a few important factors should be considered.

First—Permanency is essential.

Second—Its adaption to a location which will at all times afford an unobstructed view between at least two monuments.

Third—The line should at all times be accessible for both measurement and instrument work. In this case it

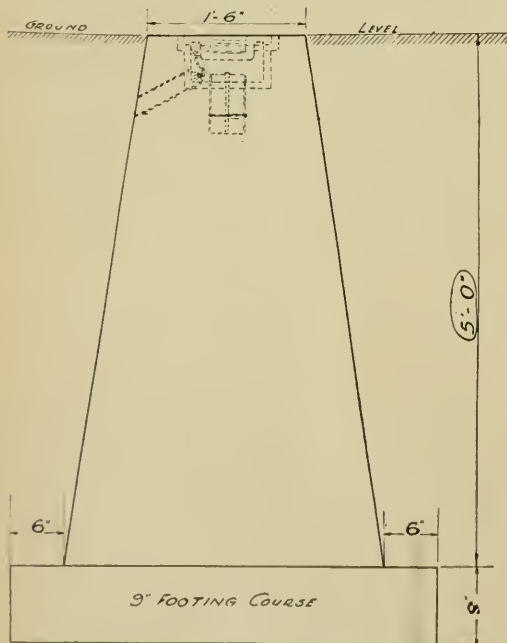


FIG. 1—MONUMENT IN ELEVATION

is well to consider future plant extensions when locating monuments. Obviously some of the monuments will be destroyed as time passes, but if a base line is to be maintained, provision should always be made for its re-establishment when necessary.

Fourth—Monuments should be located so as not to be an obstruction. In this case the only remedy seems to lie

in making them flush with the ground, thus not affecting the passage of roadways, tracks, etc. Frequently the only unobstructed territory in a plant is along a track or roadway. In order to allow the placing of monuments in exposed places, such as directly in a roadway, a special cast-

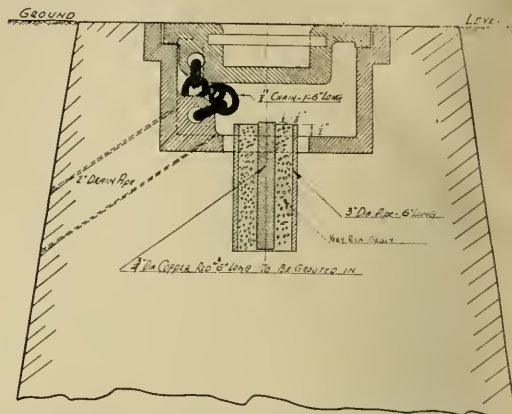


FIG. 2—SECTION OF TOP OF MONUMENT SHOWING CENTER PLUG IN PLACE

ing has been designed to fit into the top, and in which the centre point is placed.

Establishing a Base Line

The following sketches and descriptions should give the reader a clear understanding of the methods followed throughout in the designing and establishing of such a base line.

Fig. 1 shows the concrete monument in elevation. The dimension encircled is variable and may be changed to suit local conditions. Fig. 2 shows a large scale section of the top of the completed monument, with the centre plug in place. A section of three-inch pipe, 6 in. in length, is inserted in the bottom of the plate, in which to grout the centre plug after the concreting of the monument has been completed. The centre plug mentioned above is a 3/4-in. round copper rod, 6 in. in length.

Methods of Placing Monuments

The method of locating the line and placing the monuments is as follows: First, the line is fixed on the ground and the location of the monuments marked. In order to facilitate the making of measurements, each monument should be set at some convenient chainage, e.g. an even station plus ten, or a multiple. Should it occur that the above chainage can not be obtained, set at least to an even foot. Then excavation for the monuments is carried down to the required depth. In countries where frost occurs, care should be taken to excavate below the frost line. Footing courses 9 in. thick are poured and the forms for the monument set in place. It is always wise to place a footing course under each monument, as it counteracts any tendency to settle. After the forms are set, they should be carefully lined in and checked for chainage, and the plate, with pipe inserted as shown in Fig. 2 should be placed in its proper position. The drain pipe should also be placed in position, the actual slope given being sufficient to carry off any water which may collect. When this is done, they may be filled with concrete, using a 1-2-4 mixture. Before the centre plugs are finally lined in and centred, time should be allowed for the concrete in the monument to set.

When everything is in readiness for the final work of establishing the line, a small quantity of very rich concrete is prepared and placed in the pipe in each monument. The copper plugs are quite easily driven into this,

lined in with a transit, and carefully set at the required chainage. After the plugs have been thus set, great care should be taken not to disturb them until the concrete in the pipe has sufficiently set to hold them in place, when precise line and chainage may be marked on them. The most convenient centre mark, which answers for both line and chainage, is a cross scratched on the head of each plug with a sharp edged tool. It is wise to make each cross accurately with a pencil first. Great pains should be taken to have all plugs accurately centred, the work being done with an instrument which is in perfect adjustment. Should any doubt be entertained as to the adjustments, the instrument should be reversed on all points given in order to eliminate any possible chance of error. In chaining the distances it is well to check and re-check all measurements with a chain or tape which is accepted as standard. It is especially necessary to re-check all measurements made under unfavorable conditions.

This finishes the work as far as line and chainage go, and now comes the task of running a line of precise levels on the centre plugs. The elevation of each plug should be very carefully noted. In this also great care should be exercised to have all elevations exact, and tied into some accepted bench mark previously set.

The writer has tried to describe the methods employed as clearly as possible, and feels confident that if every plant were to adopt such a means of coping with its engineering problems, of which a great number arise from lack of information, there would be fewer grey hairs in the field engineer's head.

RECENT DEVELOPMENTS IN CONCRETE

SPEAKING before the Montreal Branch of the Engineering Institute of Canada, on April 27, Lieut.-Col. H. C. Boyden of the Lewis Institute, Chicago, in his lecture on "Recent Developments in Concrete," said that until recent years the progress of concrete had been left to constructors supplemented with some laboratory investigation on a small scale. As a result of lack of definite knowledge erroneous ideas had developed, an because of such ideas enormous losses have been caused. In the United States last year, a year not normal in construction, \$1,000,000,000 had been spent for concrete in various forms. Owing to the fact that the fundamental laws of mixing had not been carried out, that work could have been increased in value by 25 per cent., and in his personal opinion, 33 per cent., a loss in value alone of from \$250,000,000 to \$330,000,000. Briefly the owners were not getting what they had paid for.

Col. Boyden then explained the foundation of the laboratory at the Lewis Institute where tests are conducted at the rate of 75,000 a year. The head of the Institute had been given an ample endowment, not to waste, but enough to carry out experiments and investigation until he was able to find the right answer. It was five years before the first investigations were made known. Some investigations had been going on for two years, and the solution would not be arrived at for two or three years and, perhaps ten, but it would mean the right answer and it would not be given out until ready. There was only one instruction given to Professor Abrams, and that was: Find out all about concrete.

Then followed a review of the mixing of concrete, a talk on the ingredients, cement, sand, stone and water, with emphasis laid upon the necessity for clean sand. It was pointed out that dirty sand would lessen the compressive strength of concrete by 25 per cent. While much discussion had taken place about the first three ingredients, the water had been practically neglected, and yet water was the controlling factor in the making of good concrete. This led to a lengthy review of the water-cement ratio. The less water used for a given amount of cement the stronger the concrete. The more water used, the weaker the concrete.

Col. Boyden dealt with the new form of specifications, criticized building codes, and declared that many designers were working on the factor of safety, because they had not the courage to say to the contractors: Give us the proper concrete. Under the new knowledge it is possible to buy concrete as a finished product.

As an example of construction erected under the Abrams specifications, Col. Boyden instanced the new building of the Canada Cement Co. in Phillips square, a \$2,000,000 structure, where the average variation was only 1 3-10 per cent. from the desired result. This he quoted as an example of the manner in which the members of the association are willing to work upon their own ideas.

PRACTICAL ISSUES OF HIGHWAY PROBLEMS

PROBLEMS of the highways formed the central theme of an interesting address delivered recently before the Quebec branch of the Engineering Institute of Canada, by Alexander Fraser of the Quebec Provincial Highways Department. Mr. Fraser touched upon the practical issues of the problem from a two-fold standpoint: 1, the standpoint of the financier and of economy; 2, that of the work itself. The problem of economics was difficult enough. "I can give no better illustration of this fact," he said, "than by pointing to the varied systems and laws governing highways throughout the United States and Canada. The differentiations of the laws arose doubtless in the first place from the differentiations in the systems employed. All of which arose very likely from the difference in point of view upon similar problems."

"Despite these differing points of view, however, and the different systems and laws resulting, it was evident" said Mr. Fraser, "that there was a very marked tendency in one direction. This was on the principle that each one should pay his share toward the expense of making and maintaining highways."

"The chief factors involved in the technical work governing construction are the types of local material to hand, the nature of the soil, with the local conditions governing drainage, the cost of construction, and the facilities offering for future work, the financial means at the disposal of the department, the difficulties from the point of view of the work itself, the nature of the adjoining properties, and the general topography of the vicinity of construction being carried out. It is only by virtue of a thorough knowledge of all these factors that the engineers can finally decide upon the exact location for the needed enterprise."

SOME PROBLEMS IN SURVEYING.

BEFORE the Halifax branch of the Engineering Institute of Canada, at the last monthly meeting, an interesting paper was read by H. B. Pickings on "Some Problems in Surveying" with special reference to the difficulties and embarrassments with which the surveyor is confronted in attempting to reach the necessary degree of accuracy and finally in the delimitation of "lots, pieces and parcels" of real estate and to reconcile errors and discrepancies between ancient and often crudely prepared plans, deeds and descriptions, and present conditions and boundaries of properties. It was difficult and often impossible to find or identify the ancient marks and monuments delimiting a piece of property and therefore correspondingly so not only to adjudicate equitably between a seller and a purchaser, and to satisfy the legal requirements in the often complicated process of transferring property from one owner to another.

In the discussion which followed the chairman expressed the opinion that a vast amount of trouble would have been saved, if in the descriptions of properties by metes and bounds the true or astronomical meridian had many years ago been made compulsory in all surveys, plans, deeds and descriptions of properties, instead of the generally used magnetic bearings which vary from year to year and by local attraction from place to place.

UTILITY OF MODULAR RATIO QUESTIONED

Cracking Said to Resolve Reinforced Concrete Beams Into Trusses — Resistance Columns Calculated Without Reference to Modular Ratio.

DOUBT is thrown upon the generally accepted theory of reinforced concrete so far as it depends upon the modular ratio, by H. Kempton Dyson, in a recent paper before the Concrete Institute. According to the author, the resistance of a reinforced concrete beam arises from its action as a truss rather than as a composite beam, and consequently the value of the modular ratio does not affect the problem. He takes the position, further, that in view of the construction in the concrete of a reinforced concrete column, the resistance of the steel has nothing to do with the modular ratio, but should be figured as that due to a series of short struts.

Effect of Cracking.

Mr. Dyson advances the view that although cracks in properly designed reinforced concrete beams are very small, the structures are really compound ones in which the concrete and steel act as separate elements, though connected together. Thus, in reality, such a member is not a beam—it is more in the nature of an arch or elemental frame. The manner of behavior of a characteristic beam loaded at two points is indicated in Fig. 1. The dotted lines represent the compression struts which are virtually created in the concrete of the beam, forming, as it were, the compression chord and end posts of a truss. When web members are introduced, the construction takes the form of a trussed frame as shown in Fig. 2, this being

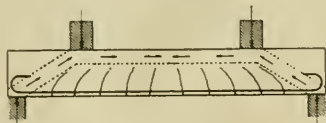


Fig. 1—Truss Action of Beam With Two Concentrated Loads

analogous to a Warren girder. The horizontal steel in such construction forms the bottom or tension chord of the truss.

Common Theory Questioned.

The author points out that the ordinary current theory, to which Professors Hatt, Talbot and Withey in America, and Professors Marsch and Bach in Germany, made notable contributions has been in reality adjusted to fit the facts by using a coefficient labelled "modular ratio" so selected as to make the formulae fit the experiments. The view is advanced that we are not sure as to how a so-called beam of reinforced concrete is really going to act and that it may be a kind of arch, a simple frame, or a truss, or in the case of a slab resting on its edges, there may be developed a sort of dome, cone or pyramid within the thickness. The beam theory to be applied to such a condition must of necessity be adjusted to an important extent.

The action of the horizontal steel as a virtual tension chord of a truss is supported by the evidence built up in recent tests that there is a gradual sliding of the bars in the concrete as the loads increase. In accordance with which most of the pull is taken by the hooks or other anchorages at the ends. If, therefore, there is little stress transferred to the horizontal steel in the central portion of the beam, this steel would undoubtedly resemble that in a tension chord.

Distribution of Compression.

If a concrete beam be regarded as a virtual truss the distribution of the compressive stress may be quite different from that commonly assumed. Thus, if horizontal compression is applied to the top chord of a truss below the

centre of gravity thereof, the compressive stress will be higher on the lower edge than on the upper edge. A striking illustration of the possibility of such a distribution over the entire depth of the concrete beam of special form is contained in Fig. 3. Here compressive stress is actually greater at the bottom of the beam than at the top.

Comparative Costs.

The author designs slabs varying in thickness from five to eight inches for an assumed loading in accordance with the ordinary theory and in accordance with his own

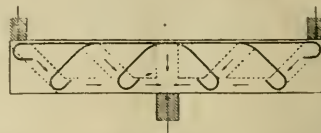


Fig. 2—Resolution of Beam Into Virtual Warren Truss

method, assuming for the latter two distributions of the compressive stress, namely the triangular and elliptical distributions. It is found that practically no difference in cost arises for the thicker slabs, but by thinning the slabs and using the author's method there is a considerable saving effected.

Columns.

Exception is taken by Mr. Dyson to the current methods of calculating reinforced concrete columns. He points out that doubts have been thrown in recent years upon the adequacy of the common theory by reason of increasing knowledge of the phenomena of shrinkage and flow under stress. An argument similar to that advanced by Franklin R. McMillan before the American Concrete Institute at its last meeting is put forward. The author holds that the creation of an initial condition of tension in the concrete through shrinkage and a corresponding initial compression in the steel upsets any ideas we may have concerning the stresses in the concrete and steel being proportionate to the ratio of their moduli of elasticity. He declares that so long as adequate precautions are taken to prevent buckling of the steel we may calculate the resistance of a column without paying any attention to the modular ratio and consider it merely as made up through the concrete being able to withstand as much as it would if it were plain concrete and the steel as much as it would in a short steel column. The addition of the two would then represent the total resistance of the reinforced concrete column. A method of proportioning ties to prevent the reinforcing rods from buckling is outlined.



Fig. 3—Distribution of Compressive Stress in Special Beam

According to the theory the ties or links should be spaced not further apart than sixteen times the diameter of the vertical rods for the smaller sizes, and at a reduced spacing for larger rods. He personally adopts as a standard 8 inches throughout for all columns containing rods over 2 in. in diameter.

The Niagara Peninsula Branch of the Engineering Institute of Canada held their annual meeting at St. Catharines on May 5, when the following officers were elected:—Chairman, F. S. Lazier, Thorold; Vice-Chairman, S. R. Frost, Niagara Falls; Directors, F. W. Clarke, Niagara Falls; A. Milne, St. Catharines and Mr. Downey, Thorold.

THE SUB-SOIL OF MONTREAL*

Character of Rocks, Gravels and Clays Underlying Montreal
— Nature of Sub-Soil and its Suitability for Building
Sites—Application of Geology to One Determination

By Adhemar Mailhot,

Professor of Geology, Polytechnic School, Montreal.

GEOLGICAL formations of the sub-soil of Montreal are divided into two groups, the first belong to the Paleozoic era with which are connected the formations of solid rock that constitutes the substratum of the island; the second comprises the deposits of the Quaternary era, that is to say, the deposits of the Pleistocene and Recent epochs. The rocks of the first group are geologically very old, and since the day of their formation they have been consolidated into rocks sufficiently coherent to be utilized as building materials without undergoing any treatment other than dressing. The formations in the second group, on the contrary, are in practically the same condition as when they were formed. The deposits of these two divisions are, consequently, very different. At Montreal there is no evidence, either of the later part of the Paleozoic era or of any part of the Mesozoic and Cenozoic eras. If deposits were formed during these periods, they were completely carried away by erosion, and there is now a gap between the Devonian and Pleistocene periods.

The consolidated sedimentary formations which form the sub-soil of Montreal belong to the Cambrian and the Ordovician, two subdivisions of the Paleozoic. These formations occur in the following order beginning with the oldest:

1. The Potsdam Cambrian sandstone which rests directly and unconformably on the pre-Cambrian complex is 429 ft. thick at Saint-Canut and more than 1000 ft. thick at the wells of the Gas Co. at Montreal.

2. Above the sandstone are the following Ordovician formations. Beckmantown or Calciferous (sandstone), 1065 ft.; Chazy (limestone), 785 ft.; Trenton (limestone), 695 ft.; Utica (shales), 210 ft.

If you were to sink a shaft somewhere at Point Saint-Charles you would meet with all these formations in turn. These rocks form bands very nearly parallel to the Laurentian border, somewhat after the manner of a deck of cards, the first card, underneath, would represent the Potsdam sandstone, the next the Beckmantown, the third the Chazy, the fourth the Trenton, and the fifth the Utica shales.

Evidence of Volcanic Activity

Towards the end of the Devonian period, at the time when the preceding formations were laid down, the plain of the St. Lawrence in the vicinity of Montreal must have been the theatre of great volcanic activity of which we have proof today in the line of igneous hills which extend from Mount Royal to Mount Shefford. These hills, of reduced size, represent the bases of these early volcanoes, or in some cases, laccoliths, uncovered by the subsequent erosion, which acted continuously on the geological formations of the valley of the St. Lawrence from the Carboniferous era to the Pleistocene or Glacial period.

The igneous mass of Mount Royal occupies a surface of 1½ square miles; it is surrounded by the Trenton limestone, through which it has opened a passage. The principal part of the mountain is formed of *Essexite*, a dark coarse-grained rock somewhat like a granite. Later this *essexite* was cut by an intrusion of *nepheline syenite*, a rock which is of similar origin to the former; it represents a more acid phase of the primitive magma. The *nepheline syenite* occupies a relatively wide band on the north-west side of the mountain, and elsewhere on the mountain it forms little isolated patches. It is a rock of finer grain and lighter in color than the *essexite*.

Associated with these intrusions there are a great variety of dykes, that is to say, walls of igneous rock, more

or less inclined or vertical, that cut, in all directions, the *essexite* the *nepheline syenite* and the surrounding sedimentary rocks. There are also numerous beds of similar composition, intercalated between the layers of the stratified rocks. These dyke rocks are also, in origin, connected with the *essexite* and *nepheline syenite*; they bear such names as *bostonite*, *camptonite*, *ainoite*, *tinguaita*, etc. They represent the last phase of volcanic activity in the Island of Montreal. You meet with these dykes wherever there are extensive outcrops of rock in the neighborhood of Mount Royal as in Mount Royal Park, in the Mile-End quarries, at Outremont and at St. Helene Island.

The different formations that we have just described formed the surface of the Island of Montreal before the Pleistocene or glacial period. This surface was much more hilly than it is now, and it is owing to the deposits of the Pleistocene and Recent epochs that the surface of Montreal Island is as level as it is now. Outside of Mount Royal the most important topographical variations are the two patches of *leda clay*, surmounted by the *saxicava* sands at the western extremity of the island. In addition there is the escarpment cut by the St. Lawrence which, in general, parallels the Grand Trunk Railway from near the village of Pointe Claire as far as the city of Montreal and even beyond to Pointe aux Trembles.

Mount Royal.

Mount Royal itself owes its elevation above the surrounding country to the fact that the rocks *essexite* and *nepheline syenite* that form it, are harder and more resistant than the Trenton limestone through which they have penetrated. Mount Royal might be compared to a knot in the floor of the valley of the St. Lawrence.

The deposits of the Pleistocene and Recent periods, that are commonly called the "drift" formations, may be classified in the following way, in descending order.

Recent period—River gravels. Lacustrine deposits, comprising lacustrine clays, shelly marls and peat.

Pleistocene or Glacial period—*Saxicava* sands and gravels, with glacial deposits. *Leda clay*. Boulder clay.

Pleistocene or Glacial Period.

Boulder clay is in a general way, a mixture of fragments of rock, in which the sides of the fragments may vary from blocks weighing several tons to the finest dust. The coarsest fragments are generally pretty well rounded and frequently present striae on one or several faces. These striae are characterized by stones which form the glacial moraines. The fragments are imbedded in a compact, fine grained clay, without any regular distribution.

This boulder clay covers almost the whole of the Island, although in some spots it in turn is covered by the more recent formations of the Pleistocene. With the exception of the Paleozoic outcrops on Mount Royal and around it, the boulder clay covers the rocky crest that occupies the centre of the island. In the northern part of the island it is generally of no great thickness, and even disappears completely around the rocky escarpment that follows closely the line of the river at a short distance from the latter, from Longue Pointe towards the north as far as the chapel of the Reparation, near the end of the Island, turns towards the West by Des Prairies River and extends to the Bas du Sault, thus allowing the Trenton limestone to crop out on almost the whole length of this strip in the form of a horse-shoe.

The surface of the boulder clay is very uneven. When it crops out it is owing to erosion, and then the surface of the formations seems to us fairly regular, but the surface of the boulder clay on which the *leda clay* was deposited, was irregular. This fact is well illustrated at the factories of The Terra Cotta Lumber Co., at Lakeside, where the *leda clay* has a depth of 26 ft., while the railway, close beside it, rests on the boulder clay.

Leda Clay

The *leda clay* is a gray or bluish gray clay, presenting at times a sort of stratification. It contains marine fossils, among which the most characteristic is the *leda glacialis*.

*Paper read at the Town Planning Convention, Montreal.

whence it takes its name; consequently it is a deposit which was formed at the bottom of the sea. The leda clay often contains beds of gray sand which accentuate its stratification. In the upper part of the leda clay these beds of sand become more and more numerous and they are often rich in to Villeraie, covering the greater part of the districts of organic remains, especially in shells of lamellibranchs. The leda clay may, then, be divided into two parts, the lower one-clayey, with few fossils, containing only shells of the leda glacialis and inaccomma greenlandica, the upper one, sandy, containing a rich boreal fauna. The largest area of leda clay on the Island of Montreal occupies the whole of the northern extremity of the Island from the Bas du Sault, to Bout de l'Île, along the Prairies River, and from the Bout de l'Île, to Maisonneuve along the River St. Lawrence. It penetrates also into the city of Montreal and forms the escarpment which supports the saxicava sands, which escarpment extends from Maisonneuve to Guy Street along Sherbrooke Street. This area of leda clay extends towards the north through Lafontaine Park to the vicinity of the old Mile-End quarries, and occupies also the present site of the Angus Works as far as Rosemont Boulevard. There is still another strip of no great extent at the outskirts and to the west of Westmount Station as far as Montreal West. Finally, other isolated strips are found between Blue Bonnets race-course and Montreal Junction, on the shore of Lake St. Louis, near St. Anne de Bellevue, Senneville, etc.

Saxicava Sands and Gravels

Under the heading saxicava sands and gravels are included all the beach deposits which are formed of sand colored yellow by oxide of iron, or coarser, yellow or brown sand containing still rounded stones, (up to a foot in diameter), and containing shells in greater or less abundance such as the saxicava rugosa, whence this layer derives its name.

The croppings out of the saxicava sands form an almost continuous stretch which extends from Montreal West Notre Dame de Grace. Cote des Neiges and Outremont. In addition we meet with wide strips occupying the summit of the terrace of Sherbrooke Street from McGill University to Maisonneuve, with the exception of Lafontaine Park, where the leda clay crops out. The thickness presents variations from a few feet up to 20 ft. and more on the west side of the mountain. At the cemetery of Cote des Neiges it attains 30 ft.

River Gravels

There is a wide strip of coarse river gravel which follows the right bank of the Prairies River from the Bas du Sault to about two miles to the west of the village of Carterville. This strip has an average width of about $\frac{1}{2}$ mile. This gravel, as a general rule, rests on the boulder clay, but also, sometimes, on a thin bed of leda clay. There is another strip of gravel $\frac{1}{4}$ mile wide by $1\frac{1}{4}$ miles long, on the south-east side of the Lachine Canal, to the west of St. Paul Boulevard.

Deposits of Drained Lakes

The most recent natural deposits of the Island of Montreal consist of stratified clays, shelly marl, and peat, which have been deposited on the bottoms of lakes which have been drained since the occupation of the country by civilized man.

There are little strips of lacustrine deposits along the aqueduct, near the Lachine Rapids, these deposits being formed of shelly marl covered with peat and also by stratified lacustrine clay underneath the marl.

The largest of the lakes of Montreal Island called in geology, Lake Turcot, extends from the station at Montreal West on the Grand Trunk Railway, as far as the Cote St. Paul road. There was also at one time a lake in the course of the Molson stream at Vieuxville. Finally peat along with marl is found on the Cote St. Michel road.

Sub-Soils and Building Sites

The character of the sub-soil should guide us in part, at least, in the choice of a site for a building. The sub-

soils that are to be met with in Montreal and its vicinity are. 1. Boulder clay. 2. Leda clay. 3. Sand. 4. Gravel. 5. Solid rock. The boulder clay and the leda clay will give damp cellars and it is absolutely necessary to provide for the installation of a good system of drainage under the foundations.

The sand and gravel will provide dry cellars if the drainage underneath is satisfactory, which is the case, it may be said, for the most part, in regard to the sand and gravels of Montreal Island. It is to be noted that if the sand and gravel rests on a bed of clay, in the form of a basin, a sheet of stagnant water will probably be formed on the clay. Such conditions may be injurious to health, in fact it is to such conditions that they have attributed, in London, the propagation of phthisis in certain districts. The same results would evidently follow in the case of foundations set on boulder clay or leda clay, if the drainage conditions were not good.

As for the stability of a foundation, the solid rock is the ideal, but, nevertheless, boulder clay, because of its compact nature, is almost as good, after it has settled. Foundations on gravel are also generally very safe for dwelling houses, but if there is a substratum of leda clay in a spot, it is dangerous. The numerous fissures which have appeared of late years in dwelling houses and other buildings erected on leda clay, between St. Catherine and Sherbrooke Streets, and between Metcalfe and University Streets, are sufficient proof that we should avoid leda clay for the foundation of a residence.

The character and the depth of the drift are of great importance in the case of large buildings or important works of civil engineering. One must remember that it is always possible to meet with moving sands in the drift, as, for example, in the boulder clay. In some cases it is necessary to start the foundations of a building on the solid rock but often, when the sub-soil is favorable, this is not necessary.

In the lower part of the city of Montreal, let us say below Sherbrooke Street, the rock is found between 20 and 75 ft. or more from the surface, but the boulder clay generally constitutes a bed sufficiently safe for most buildings when it contains no lentils of moving sand.

When gravel or leda clay covers the boulder clay it becomes necessary to sink pillars of wood or concrete at least as far as the boulder clay, or what is still better, as deep as they will penetrate.

When the boulder clay contains lentils of moving sand, it becomes necessary to sink caissons under compressed air at sufficient pressure to prevent the moving sand penetrating into the caisson, until the solid rock has been reached. One can then rest the foundation directly on the latter.

Rock Contour Line

The depth of the solid rock in the city of Montreal is a question of the utmost importance from the point of view of choosing a site for a large building. The figures that M. J. Stanfield compiled for the Geological Survey of Ottawa, and which he obtained from the different municipal technical services of the cities of Montreal, Westmount, Outremont, Montreal West, etc., enabled him to make the following generalizations.

The contour line 10, that is to say the line that follows the solid rock at a depth of 10 ft., envelops Mount Royal in the following direction. If one starts from a point about 200 ft. south of Masson St. on Boulevard Pie IX, this line traverses the Angus works, follows closely Mount Royal Avenue, passes slightly to the south of this street in the vicinity of Papineau Avenue and follows this direction as far as Saint-Denis Street, from there it bends towards the south and comes out nearly at the corner of Pine Avenue and Park Avenue; from this point it passes to the corner of Milton and University Streets, and from there it goes towards the corner of Peel and Sherbrooke Streets; then it follows, approximately, Sherbrooke Street as far as Atwater Avenue, where it passes a little to the north of Sherbrooke Street and continues thus along the Cote St. Antoine Road to about Roslyn Street in Westmount; from there it turns almost at a

right angle towards the north, and reaches, zigzagging, and rounding the mountains, the village of Cote des Neiges; from there it reaches and follows the line of the Canadian Pacific Railway to the vicinity of Park Ave. and Van Horne Street, and then, making a deviation of 90 deg. goes towards the north-west, and envelops the village of Youville.

In a general way it may be said that inside this contour line, the rock is found at a very slight depth from the surface, and that consequently this part of the city is well adapted to the erection of large factories, office buildings or large departmental stores, which require a firm and solid foundation. Such large buildings could be erected at a much lower cost for the foundations than the majority of similar buildings that would be erected between this line, as it has just been traced, and the River St. Lawrence. Greater stability and less capital invested should be the strongest reasons that can influence the choice of a site within the region that has just been described, for the future erection of several large buildings.

Geological conditions enable us to foresee that the district between Park Avenue and Iberville St., from Mount Royal Avenue to Mile-End station, and beyond will become a few years from now an important commercial and manufacturing centre.

Immediately to the south of the line just traced from Boulevard Pie IX to Westmount, the rock dips rapidly, so that if one were to remove entirely the drift formations from the surface along this line, one would obtain an escarpment 30 ft. and more in height at almost all points. That is to say that the contour line 30 follows closely that of 10. We must, however, make an exception of a stretch just to the north of Ontario St. from about Moreau St., as far as a point to the east of Boulevard Pie IX, where the solid rock crops out at the surface.

In a general way, in the city of Montreal, the depth of the solid rock beneath the surface increases gradually as it nears the river; this fact is well illustrated on University Street; at the corner of Milton Street the rock is found at a few feet from the surface, while 300 or 600 ft. farther south the rock is found about 50 ft. beneath the surface. From the eastern extremity of the Lachine Canal and to the south of St. James, Craig and St. Catherine Streets, in the east of the city, the rock is found at depths of between 60 and 90 ft.; however, there seems to be a rocky crest that is not so deep, where the rock is found at depths varying from 12 to 26 ft., along Bleury Street between Laguchetiere and Ontario Streets, this crest having a width of about ½ mile. This section in the lower part of the city would seem to be the most favorable for the construction of foundations on the rock.

Rock Slopes Toward River.

In a general way it may be said that the surface of the solid rock has a gradual slope towards the river from the rocky plateau that encircles Mount Royal, a slope which may be compared to that of the present or actual surface, in the same district.

That is what the present knowledge of the geology of Montreal can teach us as to the nature of the sub-soil that one may expect to meet with in excavating for a foundation. It is unnecessary to add that this data is not complete.

With regard to this matter, I shall venture to suggest to the municipal authorities the creation, for the city of Montreal, of a geological bureau connected with the public works departments, this bureau, to have as its object, the compilation of data relative to the sub-soil of the city, the interpretation of the results of underground borings and the making of a detailed geological map, on a large scale, of the city of Montreal and vicinity.

In conclusion, I venture to suggest that the municipal building regulations should take into account the geological conditions of the sub-soil of the city of Montreal; one should, for example, reserve certain districts, where the conditions are most favorable, for the erection of factories and large buildings, concentrate dwelling houses on sites formed of sands and gravels, where it is possible to have solid enough foundations, and where there will be no reason to

fear damp cellars, and finally, to set aside for amusement parks, the areas covered with leda clay, which as a rule are not favorable to the erection of dwelling houses.

ONTARIO HIGHWAY PROGRAM

When discussing his Highway Improvement Act before the Ontario Legislature on May 9, Hon. F. C. Biggs, Minister of Public Works and Highways, gave a comprehensive survey of the Government's highway program to the end of 1924.

The program which he submitted to the House was inclusive of the work done since the inception of the present provincial highway plans in 1918, and consequently a considerable portion is already complete, and expenditures totalling \$18,300,000 made. With these inclusions, the program calls for a total expenditure of approximately \$55,000,000 by the end of 1924.

Mr. Biggs explained that the plans outlined would not put the whole 1,812 miles in a "a state of perfection," but would put them in a condition to bear the traffic upon them. Of the fifty-five millions, \$49,920,000 was required for roadways, \$5,000,000 for bridges and culverts, and \$3,079,000 for connecting links in unseparated towns and villages.

Of the total amount, the Minister figured on securing \$10,000,000 from motor licenses; \$4,500,000 from Federal grants, \$10,000,000 from the twenty per cent. assessments paid by the counties, and \$3,200,000 from the cities as their twenty per cent of the cost of suburban area roads. This would leave \$27,500,000 to be raised by the province.

The amount would be expended as follows: In township grants, \$2,000,000; in county grants, \$15,000,000, and on provincial highways, \$38,000,000.

The program for the suburban areas constructed called for 149% miles of concrete, 150% miles of asphaltic concrete, 6% miles of asphaltic concrete, using gravel aggregate, 22 miles of oil penetration, and 2½ miles of gravel, involving a total expenditure of \$16,704,000.

For the whole 1,812 miles the types were: Concrete, 205.67 miles; asphaltic concrete, 189.06 miles; asphaltic concrete with gravel, 27.96 miles; oil penetration, 167.57; oil macadam, 343.01, and gravel, 876.73.

Mr. Biggs spoke of the advantageous prices which were being quoted by contractors this year, stating that on 131 contracts let so far this year, the prices were probably 15 per cent. below last year's figures. The number of tenders was very large, and the competition keen.

He alluded to the effort being made to beautify the sides of the highways by planting trees and establishing parking places for the benefit of visitors and natives, as well, regarding the results as more than justifying the money spent.

GOOD ROADS LEGISLATION IN QUEBEC

IMPORTANT amendments have been made to the present good roads legislation. Provision is made for a new department called the "Maintenance of Roads Bureau," to be directed by a general superintendent, having authority to fix roads in backward municipalities and charge the cost. The bill also provides for a petition from the Municipality to the Department to carry out all the maintenance work, on a 50 per cent. basis, or even more, if the circumstances warrant it. Another feature worth noting is the amendment which brings all village streets under the same jurisdiction as township roads, and thereby permits them to share in the government grants, and benefit by department inspection and standards.

The Town Planning Commission recently formed for Montreal, will, it is understood, comprise, James Ewing, Professor Alex. Farley and Dr. Atherton, with Jules Crepeau and S. Fortin as ex-officio members.

STANDARDIZED SPECIFICATIONS FOR MINERAL AGGREGATES FOR ASPHALT PAVEMENTS*

Not Desirable to Have Too Rigid Specifications for Aggregates — Sheet Asphalt Paving Mixtures — Proposed Asphalt Concrete Specifications

By Roy M. Green,
Manager, Western Laboratories, Lincoln, Neb.

MANY of the other details involved in arriving at satisfactory standard specifications for the construction of the various types of asphalt pavements are much simpler of solution than that of drawing up a suitable standard for the requirements of the mineral aggregates which might be universally adopted. For example, the asphalt cements that have been successfully used for the various types of work have been classified and placed in suitable groups for description in specifications and their physical properties are carefully controlled by the producers. Since the physical and chemical properties of the asphalt cements that have been used successfully are known, and there are relatively few producers of such materials, it is much easier to arrive at a suitable specification for them than is the case with the mineral aggregates where there are just as many different classes of materials as there are deposits of rock and gravel and their properties cannot be controlled further than to regulate the maximum size of the particles and the variation in sizes. Realizing these facts, it is readily appreciated that the materials available for use for any type of pavement in the different sections of the country will vary through a wide range.

Flexible Specifications Desirable

Since it is always desirable to obtain the best material in each locality, if it can be done economically, it is impossible to draft a standard which will be suitable for all parts of the United States. For these reasons, the writer believes that the standardization of specifications for the aggregate to be used in the various asphalt pavement mixtures should not be arbitrarily drawn, especially since there is a tendency of many engineers to adopt standard specifications blindly without regard to local conditions of supply or local experience with materials that have been used successfully. A standard specification for aggregate is of no value except as a guide in drafting specifications for local conditions and as a means of pointing out to the average engineer those points which should be taken into consideration in the description of materials desired for a specific purpose. The adoption of a standard specification, in its entirety, often shuts out some local material of considerable merit, and in some cases may entirely shut out a type of construction by placing unnecessarily rigid requirements on certain materials that are essential for that type. In other words, standards for the requirements of the physical properties of aggregates should be based upon the materials available in any locality and should be drawn so as to admit all aggregates that have proven successful in like construction in the past, and should be strict enough so that all materials that have proven inferior are excluded.

In the discussion of this subject it is, therefore, my intention to discuss the physical properties that are essential to the success of the various aggregates for use in the different types of construction. The definite limiting test requirements given in the following pages are not intended for universal application but are what I consider as good practice for the materials available for use in Nebraska and adjoining states.

Since the properties of the mineral aggregate which are essential to the success of a bituminous wearing surface mixture are dependent upon the type of mixture which is contemplated, it will first be necessary to designate the types which are to be discussed.

*Paper read at the American Road Builders' Association Convention, Chicago.

For the purpose of this paper, the asphalt paving mixtures will be divided into four classes, as follows:

1. Sheet asphalt wearing surface mixtures.
2. Asphaltic concrete, with the material passing the 10-mesh sieve predominating.
3. Asphaltic concrete, with substantial proportions both passing and retained on the 10-mesh sieve.
4. Asphaltic concrete, with a preponderance of material retained on the 10-mesh sieve.

Asphalt Wearing Surface Mixtures

The function of the aggregate in a sheet asphalt wearing surface mixture is simply to furnish a medium whereby a high percentage of bitumen may be carried and still produce a mixture with density sufficient to prevent the entrance of water, toughness and elasticity sufficient to prevent cracking and spalling of the surface, and rigidity sufficient to prevent rolling and waving.

Through a long experience with this type of mixture it has been learned that this sort of a combination can best be produced by means of a mixture of properly graded sand, with the addition of a suitable amount of Portland cement or stone dust. Any properly graded sand that is made up of particles of sufficient toughness will meet the requirements for sand for this type of construction provided it is clean and does not contain too much material passing the 200-mesh sieve. The Portland cement or limestone dust is simply added to fill the smallest voids in the aggregate combination, thus promoting stability, and to increase the toughness of the mixture through the fact that the asphalt cement is absorbed by this aggregate to a very large extent. Experience has also shown that very fine sand, in large amounts will not replace the Portland cement or limestone dust as a filler but it is in fact undesirable. This point should be covered by the specifications.

Since the finished product desired for this type of construction is known, it is not necessary to specify the grading of the sand desired and subsequently repeat this in the specifications for the finished mixture, as is often the custom.

This being the case it is only necessary to specify that the sand shall be clean, hard, and durable, the grading being given in the formula for the finished mixture. The amount of material passing the 200-mesh sieve should be limited. The description of the sand could be, as follows, in the specifications.

Specification for Sand

The sand for the wearing surface mixture shall consist of clean, hard, durable grains, free from clay, loam and other foreign matter. Not more than 6% of the sand for the wearing surface mixture shall pass a 200-mesh sieve and it shall be so graded as to produce a wearing surface mixture as hereinafter specified under "Composition of Wearing Surface Mixture" when combined with the mineral filler and asphalt cement.

Since the mineral filler in the mixture adds to its toughness by assisting in retaining a larger proportion of bitumen, by absorption, it is essential that it be fine enough to act as a true filler. The description of the filler could be given in the specifications as follows.

Mineral Filler. The mineral filler shall consist of limestone dust or Portland cement, which when tested by means of laboratory screens shall meet the following requirements:

	Per Cent.
Passing 40-mesh sieve	100
Passing 200-mesh sieve, not less than	75

If this type of specification is used for the mineral aggregate it then becomes necessary to give a complete formula for the desired finished product. The following is suggested as being suitable for this purpose.

Composition of Sheet Asphalt Wearing Surface Mixture. The materials entering into the wearing surface mixture shall be combined in such proportions as to produce a mixture conforming to the following limits of composition, by weight.

	Per Cent.
Bitumen	9.5 to 12
Aggregate.	
Passing 200 mesh sieve	10 to 16
Passing 100-mesh and retained on 200-mesh sieve	5 to 20
Passing 80-mesh and retained on 100-mesh sieve	5 to 20
Passing 40-mesh and retained on 80-mesh sieve....	20 to 40
Passing 10-mesh and retained on 40-mesh sieve	15 to 45

The finished mixture shall have not less than 30% of aggregate passing the 80-mesh sieve.

Although these specifications have been reduced to a very simple statement of requirements it must be understood that the aggregate grading must be carefully controlled, within the limits given, by some one who is competent to supervise this type of construction.

Asphaltic Concrete, with the Material Passing the 10-Mesh Sieve Predominating

In this type of construction, which includes the Topeka mixture, a small amount of stone is introduced in the mixture of fine bituminous mortar. The purpose of this stone in the aggregate is simply to reduce the cost of construction by reducing the surface area to be coated by the asphalt cement, since it requires much less bitumen to thoroughly coat the stone which is replacing a like volume of fine aggregate. The stone, or large aggregate in this type of mixture does not contribute to its stability in any way as each particle is completely surrounded with the fine bituminous mortar and the larger particles are never in contact with each other. The success of such a combination is then dependent upon the correct proportioning of the finer particles of aggregate the same as in the case of the sheet asphalt wearing surface mixture. For this reason it is just as essential to produce a properly graded material having the same physical properties as the material used for the fine aggregate in the sheet asphalt. The specifications for the sand to be used in this type of construction should, therefore, be the same as for sheet asphalt.

The large aggregate is exposed in the surface of the pavement over a relatively small area of the total and it is therefore not so essential that the particles be as tough and hard as for use in mixtures where a very large area is exposed in this way. It is also absolutely essential that the maximum size of these particles should not exceed $\frac{1}{2}$ in. in diameter as they are entirely surrounded by a bituminous mortar and if the size is great there will be a much greater tendency for movement in the mixture, due to stresses at their edges.

In drawing specifications for the aggregate entering into pavements of this class it is well to specify limits of toughness and resistance to abrasion as well as requirements for cleanliness and a limit to the maximum size. The properties of the local materials that have been successfully used should be kept in mind in order that those materials that have given satisfactory service may not be eliminated by requirements that may be too strict. If this type of mixture is contemplated the following specifications for the coarse aggregate are suggested.

Stone. The crushed stone shall be produced from rock having a French coefficient of wear of not less than 8 and a toughness of not less than 8 when tested in accordance with the methods described in the U. S. Department of Agriculture Bulletin 347, pages 4 and 11 respectively. The crushed stone shall be reasonably uniform in quality and free from soft or disintegrated particles and shall vary from $\frac{1}{2}$ in. to the smallest particle retained on the finest mesh screen commonly used in stone crushing plants.

The specifications for sand and mineral filler should be the same as for sheet asphalt wearing surface mixtures as they serve a like purpose in this type of construction and should therefore be identical.

When this type of specification is used to describe the aggregates it is then essential to give a complete description of the formula for the completed mixture. A good

specification, and one which is in very common use is as follows:

	Per Cent.
Bitumen	7 to 11
Aggregate.	
Passing 200-mesh sieve	to 11
Passing 80-mesh and retained on 200-mesh sieve	10 to 25
Passing 40-mesh and retained on 80-mesh sieve....	11 to 36
Passing 10-mesh and retained on 40-mesh sieve	7 to 25
Passing $\frac{1}{4}$ -in. screen and ret'd on 10-mesh sieve	11 to 25
Passing $\frac{1}{2}$ -in. and retained on $\frac{1}{4}$ -in. screen	5 to 10

Asphaltic Concrete, with Substantial Proportions both Passing and Retained on the 10-Mesh Sieve

When Mixture is Used as a Wearing Surface. When properly designed this class of mixture produces a dense asphaltic concrete with a high percentage of well graded stone, the particles of which are in very intimate contact with each other. The function of the stone in this mixture is to add to the stability of the combination by interlocking, and to reduce the surface area to be coated with asphalt cement and thus reduce the cost of construction. In order to be satisfactory in this aggregate the stone must have sufficient toughness and hardness to resist the internal wear that may be set up in the mixture as well as withstand the shocks of traffic that come directly upon the surface of the pavement. For these reasons it is essential that the stone be harder and tougher than that used in the preceding class of asphaltic concrete.

The mortar surrounding the particles of large aggregate in this combination must be suitably designed and proportioned also, in order that it may protect the large aggregate by holding it securely in place and thus prevent internal wear. The mortar must also cushion the effects of traffic on the surface so that the shocks will not be great enough to completely crush the large aggregate. To accomplish this purpose the sand must be properly graded the same as in the two preceding classes of pavements. The following clause will cover these details.

Coarse Aggregate. The mineral aggregate shall consist of hard crushed stone or an approved mixture of hard crushed stone and gravel for the coarse aggregate. Not less than 90% of the coarse aggregate shall pass a one-inch screen. To the coarse aggregate shall be combined sand or a mixture of sand and fine stone screenings for the smaller sizes. The large aggregate, or that portion of the mineral aggregate larger than $\frac{1}{4}$ in. in diameter shall be composed of stone or gravel, all of which has been produced from materials having a French coefficient of wear of not less than 10 when tested in accordance with the methods described in the U. S. Department of Agriculture Bulletin 347, page 4. All the crushed stone larger than $\frac{1}{4}$ in. in diameter shall be produced from materials having a toughness of not less than 10 when tested in accordance with the methods described on page 11 of the U. S. Department of Agriculture Bulletin 347.

The coarse aggregate shall be reasonably uniform in quality and free from soft or disintegrated particles, or other objectionable matter occurring free or as a coating on the aggregate, and free from an excess of flat or elongated pieces.

When this type of specification is used it is necessary to also give the formula for the mixture desired. The following is suggested for this purpose.

Composition of Dense Bituminous Concrete Wearing Surface. The dense bituminous concrete wearing surface mixture, produced in the manner hereinbefore set forth, shall contain the following percentages, by weight, of bitumen and aggregate, the sieves being used in the order named.

	Per Cent.
Bitumen	5 to 8
Aggregate.	
Passing 200-mesh sieve	4 to 10
Passing 80-mesh and retained on 200-mesh sieve	4 to 14
Passing 10-mesh and retained on 80-mesh sieve....	18 to 30

Passing $\frac{1}{2}$ -in. screen and retained on 10-mesh sv. 24 to 35
 Passing 1-in. and retained on $\frac{1}{2}$ -in. screen 20 to 38
 Passing $1\frac{1}{4}$ -in. and retained on 1-in. screen 0 to 10

The finished mixture shall have from 55% to 70% of mineral aggregate retained on a 10-mesh sieve, and not less than 10% passing an 80-mesh sieve.

When Mixture is Used as Closed Binder in Sheet Asphalt Construction. When mixtures of this class are used as closed binder in sheet asphalt construction the combination is made up of a mixture of fine and coarse aggregate with asphalt cement, without the use of the fine filler of Portland cement or stone dust. The function of the coarse and fine aggregates are the same as in the case where it is used as a wearing surface. The large aggregate, however, need not be nearly so tough and hard since the shocks of traffic never come directly upon it and there is no possibility that there will be internal wear as the combination is always protected by a layer of fine bituminous mortar to a depth as great as one or even two inches.

The requirements for the sand should be the same as for other types of construction although the stone may be much softer. A suitable specification describing the stone might be as follows:

Stone for Binder Course. The stone for the binder course shall be produced from tough and durable rock having a French coefficient of wear of not less than 6 when tested in accordance with the methods described in the U. S. Department of Agriculture Bulletin 347, page 4. It shall be reasonably uniform in quality and free from foreign substances. When tested by means of laboratory screens it shall meet the following requirements and be uniformly graded between the limits given.
 Passing 1-in. screen, not less than 95 per cent.
 Passing $\frac{1}{4}$ -in. screen, not more than 10 per cent.

Asphaltic Concrete, with a Preponderance of Material Retained on the 10-Mesh Sieve

When Used as a Wearing Surface. This type of mixture is made up of a commercial size of broken stone or of "one size stone" mixed with a bituminous cement. The mixture produced in this way is not an absolutely dense solid and no attempt should be made to fill the voids with the asphalt cement. The stability of the mixture is almost entirely dependent upon the interlocking of the large aggregate, and the wearing qualities of the surface are almost entirely dependent upon the hardness and toughness of this material. For this reason it is absolutely essential that this material be as tough as possible in order to withstand the shocks of traffic and resist the effects of internal wear which is inevitable when this type of mixture is used.

The limits of the properties of the mineral aggregate that should be specified are dependent upon the amount of traffic that must be carried by the surface. If it is absolutely known that the traffic is to be composed entirely of rubber-tired vehicles and is very light it is safe to allow the use of much softer rock than if the amount and nature of the traffic is unknown or is known to be severe and to consist of a large proportion of iron-tired vehicles. If a severe traffic is contemplated it is necessary that the aggregate should be better than for any other type of asphaltic concrete mixture in as much as the aggregate must be of such quality that it is capable of carrying all the wear of traffic including internal wear and abrasion of the surface.

A reasonable specification for this type of material is that recommended by the American Society for Municipal Improvements in 1917, which is as follows:

Tests. The broken stone shall be subjected to abrasion and toughness tests conducted by the engineer in accordance with methods adopted by the American Society for Testing Materials, August, 1908. The broken stone used for the construction of the wearing course shall show a loss on abrasion of not more than 3.5% or a French coefficient of wear of not less than 11.5 and its toughness shall not be less than 13.0.

Mixture Used as Open Binder in Sheet Asphalt Construction. If this class of mixture is used as an open binder

for sheet asphalt construction the requirements of the aggregate are the same as for the aggregate for closed binder, already described.

In conclusion I wish to again draw your attention to the fact that it is not good policy to recommend, for universal adoption, a specification for the mineral aggregate for asphalt pavements and place limiting test requirements on these materials because of the fact that materials differ so widely in nature in different localities. It is always advisable to draw specifications for materials so as to allow the use of only the best materials available in any locality so long as competition is obtained and the interests of economy served. While the specifications quoted are not intended for universal adoption it should be noticed that the large aggregate should be of better quality for the cheaper types of construction than for the more expensive, the last form of asphaltic concrete requiring the best large aggregate while sheet asphalt binder and also "Topeka" may be constructed by the use of a poorer grade of stone.

For successful results with any specifications it is also absolutely essential that the mineral aggregate grading be controlled within very narrow limits by one who understands the fundamental principles underlying the various asphalt paving mixtures and who is experienced in their construction.

NEW BRIDGE OVER SYDNEY HARBOR

SYDNEY (Australia) Harbor bridge, in connection with which J. J. C. Bradfield, the chief engineer of the project, is at present visiting Canada, will be constructed from Dawes Point on the south to Milson's Point on the north.

The total length of the main bridge and approaches is 3,816 ft., centre to centre of abutments, measured along the centre line of the bridge, which is straight except for a curve of eight chains radius in the northern approach. The main bridge is to consist of steel cantilevers spaced 98 ft. 6 in. apart, with shore and harbor arms each 500 ft. long, the harbor arms to support a central span 600 ft. long. The clear span from centre to centre of the main piers is to be 1,600 ft. The cantilevers and the suspended span are to be "M" braced, with each main panel divided into four. Between the main trusses the bridge is to carry four 4 ft. 8½ in. railway tracks, each spaced 12 ft. apart centre to centre, with a side clearance of 7 ft. 6 in. from the centre of the outermost track to the nearest portion of the structure; and also a roadway 35 ft. wide between curbs and protected on each side by a steel lattice hand-rail. Outside the main trusses, and carried on cross-girders cantilevered out, there is to be a motor roadway 18 ft. wide on the eastern side and a footway 15 ft. wide on the western side.

At both the north and south ends there are to be three approach spans, each consisting of four "M" type deck trusses with sub-divided panels, and supporting projecting cross girders to carry the motor roadway and footway. The railways and roads on both the approaches will be on a gradient of 1 in 40, which will be continued to the harbour ends of the cantilever arms, but on the central suspended span they will be level and at a height of 139.52 ft. above mean sea level or standard datum. The suspended span is to have a clear headway of 170 ft. above high water, or 172.52 ft. above standard datum.

The main piers, anchor piers, and piers and abutments of the approach spans are to be constructed in concrete faced with granite masonry. The main piers are erected on foreshores which have been reclaimed, and in founding them the solid rock must be reached by unwatering in a coffer-dam or other suitable means, or by the pneumatic process if necessary, as the centre in the footings below water level must be laid on the solid rock in the dry. The other piers and abutments are well above sea level, and the excavation will be wholly in the dry.

HILLHURST BRIDGE, CALGARY

By John F. Greene

Of C. D. Howe & Co., Consulting Engineers, Winnipeg

COMPLETION of the Hillhurst Bridge in Calgary marks another step forward in the progress of a city, which is consolidating its resources against the inevitable expansion which will accompany the development of Western Canada. After having emerged from the period of mushroom growth, real estate exploitation, dreams of sudden wealth to be acquired from oil, the conservative forward-looking portion of the populace took up the reins, made up a balance sheet in which asset values were based upon earnings, not visions, and adopted a policy of constructing permanent improvements which should satisfy the needs not only of the present, but of future generations.

In the last eight years during a period in which the West has experienced no increase of population, and despite the various vicissitudes of war, inflationary boom and business depression, many such improvements have been carried through. The Centre Street Bridge, a double deck concrete arch structure, approached from the north by a heavy cut and fill, with a grade of less than 4%, made a traffic link between two parts of the city which had been separated effectively by a 15% grade. The Mission Bridge, a concrete arch structure of four spans with a 40 ft. roadway crossing the Elbow River and its islands, has

interesting to recall that a bylaw was passed in 1914 for a steel bridge practically identical with and contiguous to the old bridge, to provide additional traffic way. Upon the completion of the Mission Bridge the sentiment in favor of the concrete arch type of bridge became a settled conviction; the electorate later set aside the original bylaw for a steel structure and voted for a new concrete bridge similar to those which had been constructed. While the structure itself, with its graceful elliptical arches rising in the middle to form one long sweeping arch between abutments, is a good example of its type, the interesting features in connection with the bridge from the standpoint of the engineer or the contractor have to do with the foundations. The new structure standing just below the log dam of the Eau Claire Lumber Company, is subject to unusual flood conditions. A break in the dam, not an unusual occurrence during an exceptional flood, may result in a local concentration of such magnitude as to scour a hole 20 ft. deep in the gravel and shale. Ample evidence of the scouring capacity of the Bow River was available and the foundations were designed in the light of available knowledge.

Piers and abutments rest upon rock at a level approximately 42 ft. below the water in the tail race. Each pier supporting adjacent arches consists of a concrete beam, the shafts running down to rock. The excavation carried down through approximately 35 ft. of heavy gravel and seamy shale, was an undertaking involving much expense



HILLHURST BRIDGE, CALGARY, ALTA.

been the subject of much favorable comment from competent observers, and replaces a light steel highway bridge.

The Calgary Exhibition Board, a municipal undertaking with a business record of which any private corporation might well be proud, has contributed its quota with a large reinforced concrete grandstand seating more than 6,000; an enclosed concrete arena with a seating capacity of 3,000, built principally for cattle-judging contests, but modestly proclaimed by Calgary fans as the best boxing arena in Canada.

These structures, together with the new Hillhurst Bridge, represent expenditures approximating \$1,000,000, and made during a rest period in the growth of the city, offer substantial evidence of the faith of the populace in the future of Calgary.

The Hillhurst Bridge crossing the Bow River at Ninth Street West, is a concrete arch structure approximately 700 ft. long, consisting of five arch spans each 105 ft. long, with piers, abutments and approaches. The arches are of the spandrel fill solid barrel type, with the curve of the intrados a semi-ellipse.

The sidewalks are carried on cantilever brackets, which rest on counterforts, the moment being carried from the brackets through the counterforts to the arch ring.

The site of the new bridge stands several hundred feet east of the steel bridge which it replaces. It may be

and many setbacks. That it was satisfactorily completed is greatly to the credit of the contractors, the Fegles Construction Co., of Fort William. The project together with the other bridges and structures mentioned, were carried out under the direction of George W. Craig, city engineer, with the writer as consulting engineer.—From "Municipal Improvements," published by the Canada Cement Co., Ltd.

ENGINEERING INSTITUTE ELECTIONS

At a meeting of the Council of the Engineering Institute of Canada, held on April 18 in Montreal, the following elections and transfers were announced:

Members—Robert Angus, London; John Dow, Lethbridge; A. C. Selig, Moncton; J. E. St. Laurent, Winnipeg; Ellwood Wilson, Grand Mere, Que.

Associate Members—W. R. Alder, Cornwall; A. J. Ames, Ottawa; A. F. Baird, Fredericton; G. L. Bockus, Sherbrooke; C. H. Brabazon, Ottawa; B. E. Bury, Edmonton; M. D. Cadwell, North Battleford, Sask.; N. K. Cameron, London; S. W. Canniff, Ottawa; F. J. Clark, Lethbridge; S. H. Cunha, Montreal; J. C. Donald, Fernie, B.C.; O. W. Ellis, Toronto; R. H. Field, Ottawa; J. A. Forgues, Cartierville, Que.; G. F. H. Hilliard, Lethbridge; H. P. Keith, Lethbridge; C. C. Lessard, Quebec; Nathaniel Mar-

shall, Lethbridge; J. O. Massicotte, Montreal; H. J. G. McLean, Brantford; W. J. Moffat, Regina; J. M. Moore, London; J. C. Nash, Hamilton; T. H. Nicholson, Montreal; H. A. Small, Kingston; G. B. Snow, Chicoutimi, Que.; J. H. Summerskill, Montreal.

Juniors—Herbert Aldous, Toronto; J. W. G. Boyd, Toronto; M. G. Henderson, Lethbridge; Kenneth MacKenzie, Winnipeg; F. L. Mitchell, Iroquois Falls; Alexander Thomson, Lethbridge.

Transferred Associate Members to Members—H. A. Brazier, London; J. L. Busfield, Montreal; C. W. Cornell, Toronto; F. A. Dallyn, Toronto; E. E. Hawkins, Avonmouth, England; C. D. McT. MacKintosh, Lethbridge; Patrick Philip, Victoria; H. T. Routly, Toronto; A. E. Sharpe, Leader, Sask.; A. C. Wright, Ottawa.

Transferred, Juniors to Associate Members—D. C. M. Davies, Regina; F. P. Flett, Windsor; Sifroy Goulet, Peterborough; P. M. H. LeBlanc, Ottawa; E. N. Lyon, Bombay, India; N. G. McDonald, Oshawa; R. C. McKnight, Owen Sound; F. G. Rounthwaite, Tucker's Town; Bermuda; F. C. Rust, Toronto; D. A. White, Montreal; G. H. Wood, Ottawa.

Transferred, Student to Associate Member—J. S. Hall, London.

Transferred, Students to Juniors—Despres Dessane, Quebec; Endore Giguere, Lacine; R. W. Jickling, Winnipeg; W. B. MacIntyre, Toronto; H. D. Rogers, Gananoque.

EFFICIENCY OF TRANSMISSION AERIALS

IN a paper read before the Wireless Section of the Institute of Electrical Engineers says the "Times" Engineering supplement T. L. Eckersley described an attempt to reduce to a minimum the energy losses in the neighborhood of transmission aerials.

A large part of the energy delivered to the aerial sinks into the neighboring ground and is not recovered, and with the object of screening the earth from the electromagnetic effects of the aerial current, experiments were made which consisted in interposing between the aerial and the earth a screen of wires which was used as a counterpoise earth instead of the usual buried earth. Favourable results were obtained, a large fraction of the earth losses being eliminated. There is, however, the drawback that the wires of the screen itself may form an oscillating system, in which under certain conditions oscillations may be set up that will waste energy, and the paper suggested methods by which these losses may be eliminated.

Screens have been successfully employed at large stations such as Clifden, where now only one-sixth of the power is required to produce at Glace Bay signals equal to those produced by the spark station. The practical point is that it is much cheaper to erect a 400 ft. aerial, say, with 40 jars capacity than an 800 ft. aerial with 20 jars, and even cheaper still a 200 ft. aerial with 80 jars. The height rather than the area is the difficulty. If sufficient care is given to the improvement of the resistance, the height of the aerial can be reduced without increasing the power required for a given range.

ALBERTA ROAD DISTRICTS MAPPED OUT

TEN ROAD districts have been formed in the Province of Alberta by the Public Works Department, for the purpose of more satisfactory carrying on future road construction and maintenance programs. Each of these districts will have an average of thirty municipal or improvement districts within its bounds, and over each will be a resident engineer or inspector. These have already been appointed, in most cases from the staff of road inspectors heretofore employed by the department.

The change has been effected with a view to co-ordinating the work of the surveys and construction branches, the intention being that the district engineers shall also be in charge of the survey parties sent out during the season.

A program of work to be carried on under these district

supervisors is now in course of preparation and will be inaugurated as soon as weather conditions will permit. The organization of the work, with the districts covering the entire province, will continue when the highways commission is in operation.

REDUCED FARE TO CANADIAN GOOD ROADS CONVENTION

ANNOUNCEMENT has been made by the Canadian Pacific Railway Co. of a reduction in the summer tourist fares which will affect the cost of attending the convention of the Canadian Good Roads Association, June 13-17, at Victoria, B.C. A rate of \$110.65 has been authorized as the summer tourist fare from Toronto to Victoria and return, limited to October 31. The fare was formerly \$133.30.

PRODUCTION OF STEEL INGOTS AND CASTINGS

IN spite of the advance in the production of pig iron during March, the output of steel ingots and castings was much lower than in February, the total output being only 29,941 tons as against 42,388 tons in the preceding month. The decline was most marked in the production of basic open hearth steel ingots which in February amounted to 40,935 tons, but in the month under review totalled only 28,222 tons all made for the use of the producing firms.

Basic open hearth castings made during the month amounted to 678 tons practically all of which was used by the reporting firms. In February a very small quantity of basic open hearth steel castings was used by the makers but a larger proportion amounting in all to 472 tons was produced for direct sale.

Bessemer castings and electric steel made in March amounted to slightly more than 1000 tons which was a little higher than the corresponding figure for February. A general improvement in conditions in the steel industry was noticed towards the close of the month, although many plants were still operating at considerably reduced capacity.

POWER ALLOTTED ON ABITIBI RIVER

DISPOSITION of a large part of the electrical power stored in the Abitibi River has at last been made, and one of the most important questions affecting the power development in Northern Ontario has been settled. It has been practically decided to reserve the long Sault rapids, representing 60,000 h.p. electrical energy, for future disposition. The Hollinger Consolidated are applying for Three Carrying Places Rapids, where 40,000 h.p. can be developed, and, it is understood, has agreed to make application for this particular power.

The Temiskaming and Northern Ontario Railway, it is further understood, has waived its rights to any powers for electrification or other purposes, on this river, between Iroquois Falls and Tin Can Portage, a distance of 40 miles. It is understood, however, that they will develop a power on the Frederickhouse River for use in electrifying a portion of the T. and N. O. line in the vicinity of Cochrane. It is also understood that the T. and N. O. will seek further reservations of power between New Post, the first objective in their step towards James Bay, and their final terminal at the tide waters of the Atlantic. These reservations will aggregate two lots of 15,000 h.p. each.

The Ottawa branch of the Town Planning Institute held its annual meeting in the Carnegie Library on April 27 and considerable business was disposed of. There was a good attendance, and after the business the members listened to an interesting and technical address by W. P. Cassils, C.E., on "Curves as They Apply to Town Planning," in which he dealt with the difficulties in making curved streets and boulevards and the manner in which they might be overcome.

ANNUAL MEETING OF CANADIAN SECTION OF AMERICAN WATER WORKS ASSOCIATION

Brantford Meeting a Complete Success — Fine Attendance of Delegates — Complete Exhibition of Machinery and Supplies — Names of Delegates and Exhibitors

THOSE gentlemen who were responsible for the arrangements and their carrying out in connection with the annual meeting in Brantford last Friday and Saturday, have every reason to be gratified.

The Business Sessions of the meeting were well attended. Discussion of papers read was full and general while the exhibition was a decided success, there being 21 exhibits of water works machinery and supplies, notwithstanding this was the first occasion upon which such an exhibition had been held in connection with the Canadian meeting. There were 81 delegates registered.

At the time R. C. Harris, Commissioner of Works of Toronto, chairman, called the first session to order, about 60 practical water works men and consulting engineers were present.

C. D. Brown, Walkerville, read the minutes of the last annual meeting which were adopted.

During the reading of a paper by F. A. Dallyn, Engineer of the Provincial Board of Health, on "Government Control of Sewage" (which paper will be printed in an early issue of "The Canadian Engineer") the ballots for the election of officers for the ensuing year were counted. Messrs. A. Milne, of St. Catharines and R. L. Dobbin, of Peterborough, acting as scrutineers.

Mr. Dallyn's paper elicited excellent discussion, those taking part being Messrs. Hanna of Windsor, Milne of St. Catharines, N. J. Howard of Toronto, while J. Clark Keith of Windsor sent in a written discussion.

Officers Elected

At this point Mr. Milne announced the election of officers for the coming year. They are as follows:

Chairman, R. L. Dobbin, Peterborough.

Vice-Chairman, F. A. Dallyn, Toronto.

Sec.-Treasurer, C. D. Brown, Walkerville.

Trustees:

Retiring 1923: N. R. Wilson, Brantford.

Retiring 1924: J. J. Salmond, Toronto.

Retiring 1925: R. H. Starr, Orillia.

Theo. H. Leisen, Chief Engineer of Detroit Water Works and a past president of the parent association was president and addressed the meeting.

Mr. Dobbin's paper describing the new filter plant at Peterborough (which was illustrated and described in the November 3, 1921 issue of the "Canadian Engineer") brought out a great deal of very helpful discussion, among those taking part being Messrs. Leisen, Wynne-Roberts, Milne and Gore.

Inasmuch as it is very likely that the annual convention of the American Water Works Association will be held in Detroit in 1923, it was decided that if that should be the case, then the next annual meeting of the Canadian Section should be held at Windsor, Ont. Should Detroit not be chosen for the annual meeting of the parent body, then the place of meeting for the Canadian Section will be left to the executive committee.

At 5.40 p.m. the delegates were taken by special car to the Brantford Golf and Country Club as guests of the Board of Water Commissioners and tendered a banquet.

Short addresses were delivered by Mayor Parker, City Treasurer Bunnell, R. C. Harris and F. A. Dallyn. In the evening many of the delegates attended the armories and there listened to the band concert rendered by the Scots Guards.

Meeting a Great Success.

Taken altogether the meeting can be considered as a distinct success from the point of view of attendance, genuine interest in the papers and discussions, while the exhibit of water works equipment was decidedly successful. Considering that the Canadian Section has but about

100 active members, it shows how interested the men who supply their needs are when it is stated that no less than 21 of them sent exhibits and representatives to look after them. The exhibition was held in the Palm Room of the Kerby House. As a result of the great interest in this feature of the convention which reflects great credit upon Canadian manufacturers of water works machinery, it is to be hoped that some permanent organization of the machinery men similar to the body known as the American Water Works Manufacturers' Association and which co-operates so successfully with the parent body, may be brought about.

Delegates Present

The following are the names of those who registered: R. O. Wynne-Roberts, Toronto; Jas. J. Salmond, Toronto; G. F. Johnson, Chatham; C. E. Williams, Galt; Wm. A. Doherty, Toronto; A. S. Branstom, London; N. E. Radford, Toronto; W. T. Randall, Toronto; Jas. M. Noble, Toronto; W. S. McGhie, Toronto; O. J. Delaney, Montreal; L. H. Ronnay, Toronto; G. H. Wilkes, Galt; E. F. Hetherington, Galt; H. H. Gee, Toronto; M. A. Schroder, Sarnia; Jas. C. Atwell, Brooklyn, N.Y.; D. M. Hanna, Border Water Commissioners, Windsor; R. G. Niven, Toronto; G. H. Crase, Chatham; N. Bruce Wilson, Galt; A. S. Robertson, Woodstock; R. H. Starr, Orillia Water, Light & Power Commission, Orillia; Jas. Thomson, Hamilton; F. R. Hamilton, Toronto; A. Milne, Supt. Water Works, St. Catharines; C. A. Warder, Supt. Water Works, Niagara Falls; R. Clark, Supt. Water Works, Merriton; N. B. MacPhee, Supt. Water Works, Port Dalhousie; Vincent Voaden, Hydro-Electric Power Com., Toronto; R. C. Harris, Works Commissioner, Toronto; E. T. Austin, Belleville Water Works, Belleville; R. A. Lyons, Hamilton; J. G. Hamilton, Supt. Water Works, Scarboro; J. Wilde, Asst. Supt. Water Works, Scarboro; S. Young, Toronto; F. W. Hndson, Toronto; A. H. Howard, Hamilton; J. S. Clemens, Toronto; C. J. Archibald, Public Utilities Com., Woodstock; Geo. E. Fisher, Galt; Geo. E. Newill, Montreal; Chester Larner, Philadelphia; Ray R. Knight, Toronto; H. S. Philips, City Engineers' Dept., Hamilton; H. Killmer, Chief Engineer, City Water Works, Windsor; R. L. Dobbin, Water Works Supt., Peterborough; L. W. Smith, Galt, Ont.; W. E. West, Toronto; C. W. Schiedel, Waterloo; J. F. Hartel, Waterloo; F. A. Dallyn, Provincial Board of Health of Ontario, Toronto; A. E. Berry, Provincial Board of Health of Ontario, Toronto; A. V. DeLaporte, Provincial Board of Health of Ontario, Toronto; J. VanSchater, Toronto; N. J. Howard, Filtration Plant, Toronto; W. H. Randall, Toronto; F. C. Chadd, Water Works Supt., Tecumseh, Ont.; W. C. Miller, City Engineer, St. Thomas; A. W. Boinley, St. Thomas; C. H. Scheman, Bridgeburg, Ont.; S. S. Gear, Bridgeburg, Ont.; Wm. Gore, Toronto; Theo. A. Lelsen, Detroit, Mich.; C. H. Bromley, Grimsby; W. T. Randall, Grimsby; H. H. Jordan, Brantford, Ont.; M. Pequenalet, Kitchener, Ont.; A. Wilson Bow, Hamilton; L. O. Donnell, Toronto; H. M. Marsh, Hamilton; E. R. Gray, City Engineer, Hamilton; W. B. Redfern, Toronto; E. M. Proctor, Toronto; L. R. McPaul, City Engineers' Office, Hamilton, Ont.; Wm. Storrie, Toronto; F. H. Early, Water Works Supt., Brampton; C. D. Brown, Sec.-Treas. of Canadian Section, Walkerville; N. O. W. Millard, Brantford.

List of Exhibitors

The following Canadian firms were well represented in the Exhibitors' Room which adjoined the room in which the meetings of the convention were held:

Canadian Brass Co., Galt; C. E. Williams, G. E. Fisher; Wallace & Tiernan, Lt., J. Van Benschoten; Jas. Morrison Brass Goods Co., Ltd., Toronto; James Noble; T. McAvity & Sons, St. John, N.B.; W. S. McGhie, O. J. Delaney; Thomson Meter Co., Brooklyn, N.Y.; J. C. Atwell; Canadian Des Moines Steel Co., Chatham, Ont.; G. F. Johnston; Crane, Ltd., Montreal; A. H. Howard; Dominion Steel Products, Ltd., Brantford; H. Jordan; Goldie & McCulloch, Ltd., Galt; E. F. Hetherington, G. H. Wilkes; A. H. Winter Joyner, Toronto; N. E. Radford; Horton Steel Works,

Ltd., Bridgeburg, Ont., C. H. Scheman, S. S. Gear; Mueller Mfg. Co., Ltd., Sarnia, M. A. Schroder; Neptune Meter Co., Ltd., Toronto, W. H. Randall, W. T. Randall; Canadian Austin Machinery Co., Woodstock, Ont., A. S. Robertson; Hoyt Metal Co., Toronto, R. G. Niven; National Iron Corporation, Toronto, W. A. Doherty, F. W. Hudson; Garlock Packing Co., Hamilton, R. A. Lyons; Page Hersey Tubes, Toronto, W. E. Best; Empire Brass Co., London, Ont., A. S. Branstun; Jenkins Bros., Ltd., Montreal, H. H. Gee.

Saturday Morning, May 13

This session was opened by the reading of a paper on "Standardization of Hose Couplings," by Norman R. Wilson, Chief Engineer, Brantford Water Works, which precipitated some very helpful discussion. It was moved and seconded that the matter be brought to the attention of the Canadian Engineering Standards Association.

Prof. Peter Gillespie then presented a most interesting paper on "Manufacture of De Lavand Cast Iron Pipe," illustrated by lantern slides and moving pictures.

This was followed by a paper by Wm. Gore, consulting engineer on "Treatment of Impure Hard Water." This paper will appear in a future issue of "Canadian Engineer."

Mr. Robertson of the Canadian Austin Machinery Co. was the last speaker for the session and showed moving pictures of trenching and backfilling machinery.

Thus ended what was conceded on all sides to have been a most successful meeting of the Canadian Section of the American Water Works Association.

STANDARDIZATION OF HOSE COUPLINGS*

Reason For Large Variety of Coupling Sizes — Cost an Important Consideration — Large Thread For Couplings Advocated — Adapters Recommended For Municipalities.

By Norman R. Wilson,

Chief Engineer, Brantford Water Works.

IN this paper it is not the intention of the writer to deal exhaustively with the subject but rather to open up the subject for discussion from the viewpoint of those interested in water works matters.

The question is constantly being brought to the front with regard to fire departments but the writer has seldom heard it mentioned by water works officials.

There is no doubt that it would be a good thing to have all couplings standardized with regard to new water works installations, especially in the Western Provinces where there are so many new towns which are at the present time and will be in the future, going into the question of the installation of water works and fire protection.

The writer has on many occasions been asked why it is that there are so many sizes of couplings. The answer is a very simple one. The first protection in case of fire engines was by hand operated appliances made locally and each maker had his own threads and sizes to work to usually cutting his own dies. Then came the steam fire engines and the makers of these made their connections to fit the various hose couplings in use. In the same way when water works systems were introduced hydrant couplings were made to conform to the various existing hose couplings.

From a practical point of view the cost of altering all couplings to conform to a common standard would be so great a tax on the municipalities already equipped, that such a thing would be absolutely impossible. Take for instance the City of Toronto with 6,833 hydrants, the cost of changing the hydrants alone would be in the neighborhood of \$35,000 taking the cost of altering each hydrant at \$5. In addition to which, of course, there would be the

cost of altering all hose couplings and providing new caps for the hydrants.

The question would also come up, which department would have to pay for such alteration for though the hydrants are under the control of the water works department, the chief reason for altering them would be for fire protection.

Again the question arises what is the best standard to use. It is generally conceded that the best size of clear opening is the present standard of $2\frac{1}{2}$ in. which brings the question down to two points, namely, outside diameter of thread on the male coupling and the number of threads per inch. At present the diameters range from 3 in. to $3\frac{1}{4}$ in., and the threads per inch from 5 to 8.

A few years ago an investigation of the question was made in the United States when it was found that in the majority of municipalities, the outside diameter was about $3\frac{1}{16}$ in. and the threads per inch from 7 to 8. To suit these a standard was adopted having $3\frac{1}{16}$ in. outside diameter and $7\frac{1}{2}$ threads to the inch.

Such a thread in the opinion of the writer, is not a suitable one. In case of a fire, the main object is speed and so small a thread is very liable to cause delay by cross threading. This very frequently occurred when the writer was conducting speed tests. The larger the thread the less liability there is to cross threading and the writer has no hesitation in stating that in his opinion the best thread to use is 5 to the inch. With such a thread there is practically no chance of cross threading and it can readily be attached either in the dark or in winter.

Further it is much more readily cleared of dirt or ice than a small thread and is much less liable to breaking or burring than a fine thread.

The simplest and least expensive method for existing municipalities to adopt in order that they may render assistance to each other in case of necessity, and one which the writer induced many municipalities to use, is for them to have on hand adapters which will enable them to connect with the surrounding municipalities within a certain radius.

PETERBOROUGH BRANCH ENGINEERING INSTITUTE OF CANADA

AT the Annual Meeting of the Peterborough Branch, Engineering Institute of Canada held on Thursday evening, May 11, the following officers were elected for the coming season:

Hon. Chairman, P. L. Allison, Canadian General Electric Co.; Chairman, P. P. Westbye, general manager and chief engineer, William Hamilton Co.; Vice-chairman, R. L. Dobbin, water works superintendent, Utilities Commission; Secretary, R. C. Flitton, Wm. Hamilton Co.; Treasurer, A. B. Gates, Canadian General Electric Co.; Executive committee, H. O. Flisk, manager Electric Department, Utilities Commission; E. R. Shirley, Can. Gen. Electric Co.; W. M. Cruthers, Can. Gen. Electric Co.; A. L. Killaly, Supt. Trent Canal; A. A. Richardson, Res. Engineer, Utilities Commission; B. L. Barns, Can. Gen. Electric Co.

The annual reports of the various officers and committee chairman were presented. Fraser Keith, general secretary of the Institute, was present and addressed the meeting on the Policies of the Institute.

As a result of negotiations which have been conducted between Sir Adam Beck and representatives of the Dominion Power and Transmission Co., of Hamilton, it is understood that tentative proposals have been made for the incorporation of the Dominion Power and Transmission Co.'s lines from Oakville to Hamilton and from Hamilton toward Grimsby in the radial scheme from Toronto to Niagara Falls if that undertaking be proceeded with under the amended powers to be granted by Hon. Mr. Raney's new Hydro-Radial Bill.

*Paper read before Canadian Section of American Water Works Association, Brantford, Ont., May 12.

PREVENTION OF ELECTROLYSIS TROUBLES IN UNDERGROUND WATER PIPE*

Effect of Electric Currents on Cast Iron Pipe — Many Methods Used To Reduce Damage — Description of Pipe Drainage System — Insulating Pipes.

By E. B. Stewart.

Electrical Engineer, East Bay Water Co., Oakland, Cal.

ELECTROLYSIS may be defined as a process by which chemical changes are caused by an electric current independent of any heating effect. In order that electrolysis may occur, there must be a flow of electric current through a conducting liquid from one terminal to another, and the conducting liquid must be a chemical compound or solution which can be altered by the action of the electric current. The injury resulting from electrolysis is brought about by removal of part of the metal when the stray current leaves the metal to go into the soil. That is, the stray current can flow from the metal into the soil only by taking a part of the metal with it.

The majority of the street railways of the country are operated on the single overhead-trolley plan, with the electric current flowing onto the rails through the car wheels, after it has passed through the car motors. If the rails of an electric road are not insulated from the earth, they will not carry the total current all the way back to the power house. A part of the current will branch off into the earth and flow through the surrounding pipe structures, returning to the rails at certain fixed points. This branching off of current depends upon the conductivity of the earth, and the character and relative position of the metallic masses in the earth with respect to the rails.

Underground waters, rivers, lakes, etc., influence more or less the path of earth currents, but extensive pipe systems of good conductors have a still greater influence.

The return current will be distributed through all the conductors in parallel with the rails in the order of the divided circuits; i.e. the strength of the current in all possible paths in parallel will be inversely proportional to the resistance in each path.

The interchange of current between rails and pipes have certain earth resistances to overcome in passing from rails to nearby pipes and vice versa. These resistances are of primary importance in determining the extent and seriousness of electrolytic corrosion. Obviously no electrolytic corrosion would occur should the resistance between rails and pipes be zero, and likewise no trouble would occur should the resistance be infinitely high. Hence resistances between these extremes determine the extent and seriousness of electrolytic troubles.

In making an electrolysis survey, the underground pipe system is generally divided into zones known as Positive, Negative and Neutral zones. These zones may be best illustrated by a pipe line parallel with an electric railway from the power house to remote points near the end of the line.

That portion of the track more remote from the power house will be at a potential above the earth, and those portions of the track in the vicinity of the power house will be at a potential below that of the earth. Consequently in the outlying district these currents, after getting into the earth tend to flow as a general rule in the direction of the power house and they gradually accumulate on the pipe line. This area is known as the Negative Zone. But when they reach the region near the power house, these currents are again discharged through the earth to the negative railway structure. In this area damage to the pipes most frequently occurs and is known as the Positive or Danger Zone.

The Neutral Zone is that portion of the pipe midway between the power house and the end of the line.

The reason for failures in areas near the power house are more or less clear in a general way to everyone. But the reason for troubles in outlying areas is sometimes more

difficult to analyze. In large cities where a number of power stations are operating it is not uncommon for trouble to develop at outlying points between power stations.

Investigation very often develops that these areas are of swampy earth of very low conductivity and perhaps the rails pass around this region in a somewhat circuitous path. Consequently strong currents are set up as the current shunts from the rails and passes over the affected area seeking the rails again on the opposite side.

Another example may be illustrated by two separate tracks leading from the same power house, and laid out in such a way that the return of one is almost without loss of potential, while the other has considerable loss. In this case all the current will not return through the rails, but part of it will leak across through the earth to the track which is without loss of potential. These currents will accumulate on the pipes running in the same general direction and very often cause destruction in a very short time.

Methods Used To Eliminate Damage.

In an effort to reduce or eliminate damage to pipe systems due to stray earth currents a great many methods are in use.

Those methods which are commonly used are: (1) Surface insulation of pipes; (2) Insulating joints; (3) Pipe drainage systems.

Experience has shown that painting or otherwise insulating the surface of pipes by the use of treated paints does not give satisfactory results in areas where the pipes are carrying a large amount of current.

The primary reason for failure of paints under this condition lies in the fact that none of the paints, as you all know, are absolutely impervious to moisture. Consequently, as moisture deteriorates the paint, the paint becomes more conducting for electric current resulting in the formation of more or less gas beneath the coating. As this gas increases in amount and expands, the coating is ruptured, after which the current flow is greatly increased at the point of breakdown resulting in rapid electrolytic corrosion of the pipe.

The system of electrolysis mitigation which is most generally used is the pipe drainage system. This system is employed in a variety of forms, the principal ones being as follows:

1. Where direct ties with wires or cables are made between underground pipes and rails.
2. Where uninsulated negative feeders are run from the negative bus to the pipes.
3. Where separate insulated negative feeders are run from the negative bus to underground pipes with resistance taps taken off at intermediate points.

Of these systems the simplest and least extensive system is that of placing direct taps to the pipes in the positive zone. One difficulty of this system of multiple taps lies in the fact that the drop of potential on the pipes is always equal to the potential of the tracks. In other words, if the rails carry a large amount of current, a heavy current will also be produced in the pipes; and in case high resistance joints are encountered a large amount of current will cause heavy leakage around the joint and cause rapid destruction to the pipes. In case of a broken bond in the track system the amount of current will be considerably increased.

Pipe Drainage System.

The primary object of drainage by means of uninsulated and insulated negative feeder systems is to keep the pipe drainage system entirely independent of the tracks so that the flow of current around bad joints in the pipes will be less serious.

Fundamentally this system consists of running copper cables from the negative bus parallel with the pipe and tapping to the pipe at frequent intervals.

By the use of resistance taps the current can be controlled so that an equal distribution of current is drawn from the different taps. In this way a better distribution of the current in the pipe system can be secured and heavy current on the pipes at any point can to a certain extent

*Paper read before California Section, American Water Works Association.

be avoided, and at the same time reduces to a minimum the cost of copper cable.

Another method of pipe drainage system is that of running different feeder cables from the negative bus and tapping to the pipe at frequent intervals. In this case the feeders are designed so that practically the same amount of current will flow over the feeders from each tap and thereby produce a minimum drop of potential between points at which the taps are connected.

These systems in general practice, however are seldom employed in the manner as outlined above. The most common practice is to run a copper wire or cable from the negative bus or from negative return feeder to the pipe. In many cases pipes are connected to the rail near the substation, and very often, connections are made to the rails at points considerable distance from the station.

From a personal study of the pipe drainage systems, I am convinced that, while it can, under certain conditions be used to advantage as a secondary means of lessening trouble, its installation in large city waterworks as a principal means of electrolysis mitigation is an unwise procedure. There are, however, certain special cases where the pipe drainage methods will give fairly good results. This applies particularly to suburban areas where the pipe networks are small. Under this condition, limited drainage may offer the best means of dealing with the problem, provided there is no appreciable leakage of current from the rails at remote points from the power station.

Bonding to the rails at remote points from the power station is out of the question and should not be resorted to. As an illustration of the disadvantage of this system, we have a case where the pipe line crosses under the rails at a point 2900 feet from the power house. The reason for placing a bond at this point was obviously due to the fact that tests with an indicating meter showed the pipe to be of positive potential to the rail, and the conclusion arrived at, therefore, was that lowering the potential between the pipe and rail would relieve the pipe from electrolytic corrosion. Shortly after placing the bond to the rails at this point, trouble began to develop very close to the point where the bond was connected. No account, however, was taken of the potential of the rails with respect to the earth and also the reversal of current flow from the rails to the pipes during certain changes in the load distribution. The rails at such distances from the power stations are generally always of positive potential to the earth. It is therefore clear that while the bond has removed the discharge of current from the pipe to the rails, the pipe is still positive to the earth; i.e. the pipe is of the same potential to the earth as the rail by reason of the bond connection. Hence the increase of current over the bond produces a heavy discharge of current into the earth causing destruction in a short period of time.

To mitigate a condition of this character involves considerable expense regardless of which plan is to be employed. To attempt to correct this trouble by the proper drainage methods would not only be costly but rather uncertain; especially without certain remedial measures to be taken by the railway people. Fundamentally a drainage wire to accomplish the desired results in this case must be connected very close to the power station which would result in considerably more current being drained from the pipe, and perhaps the increase in drainage would be of such magnitude as to produce little or no change in the potential readings at the rails, hence there would be no benefit derived from this plan. In other words, the closer the drainage wire is connected to the station the amount of current picked up from the earth will increase in like proportions. And in long drainage wires the size of the wire would necessarily have to be very large to maintain a drop of lower potential than the rails.

Insulating Pipes.

I believe that the safest and most economical plan to mitigate cases of this character would be to enclose the pipe in a wooden conduit and to fill it with insulating compound. While this plan is costly it serves a double purpose;

i.e., the trouble is not only corrected at the rail, but trouble is also minimized to a certain degree, at points remote from the rails due to the fact that insulating the pipe will cause a smaller amount of current to accumulate on the pipe in outlying areas.

Another case of somewhat similar nature is where the pipe runs parallel with the rails and is connected by a drainage wire to the negative bus. This pipe is seriously affected at a remote point where the pipe crosses and runs in very close proximity to the rails.

To mitigate this case by the drainage method would necessitate extending an insulated drainage wire from the negative bus to a point in the affected area. This plan would meet with the same objections as in the previous case.

One of the objections to the pipe drainage system, and this applies to all methods that are in practice, is the fact that they are designed to relieve the symptoms and do little or nothing towards removing the cause of the trouble.

A serious objection to pipe drainage is to be found in the interchange of current between underground structures, resulting from unequal drainage. The drainage of one system of pipes will of course lower its potential with respect to the neighboring metallic structures, thereby tending to injure the latter. This in turn calls for drainage of the injured system, which may damage the first or other structures, and consequently, a system of competitive drainage is established.

This competitive system of drainage requires constant watching, as changes and extensions to the system will establish added points of hazard to the system.

Another difficulty lies in the fact that structures owned by different interests cannot be bonded together except by an agreement between the owners. This very often of itself makes it impossible to apply a comprehensive drainage system to all structures, because of the impossibility of obtaining an agreement of all owners to allow connections to their structures except on condition that another interest assume the liability for any injury which may result from such connections.

In the early stages of the practical working out of the drainage will become a menace to the system. It is largely beneficial, reducing danger in positive areas more than it increases it elsewhere.

As the system grows, the load increases; more and heavier bonds become necessary and the current in the pipes may become so great that any further extension of drainage will become a menace to the system. It is largely due to this slow and obscure manner in which trouble develops that has caused this method to be so widely used. That is, the placing of additional bonds between pipes transfers the trouble from where it has been most evident to a new location, where it may require several years to manifest itself anew. Hence the intervening lull which creates a favorable impression is sometimes difficult to dispell even when trouble later occurs.

Another disadvantage of the drainage system is that phase of electrolysis of water pipes which is caused by over-drainage of underground cable systems.

Pipes as a rule are much closer to cable conduits in the ground than they are to rails. In many cases they are but a few inches apart, and in some cases rest directly against the conduit. Under such conditions, where both metals are in wet soil a low difference of potential, say a few tenths of a volt, is often sufficient to carry current and to cause damage to main or service pipe.

It is a most difficult matter to insulate underground cables even with the most improved type of conduits, so as to prevent current flowing from pipes into them, especially when they are near points where the cables are bonded to railway negatives.

The natural attraction for current flowing upon water or gas mains is directly to the conduit, either from the mains or services. This is the case also with hydrant branches and pipes that pass into side streets. In other words, the cable conduit threads its way between gas and water services as they pass in o buildings along a street.

It happens often that pipes are damaged upon streets where there are no tracks. As a matter of fact, the tracks have nothing to do with this feature of electrolysis. In one case where a number of services were found to be leaking, investigation developed that a cable conduit passed directly under them. The services were one-tenth of a volt positive to the cables. In this case the soil was wet clay and the nearness of pipe to the conduit made up for the comparatively low potential to destroy the pipe.

This phase of electrolysis, therefore, shows the necessity of conducting tests between pipes and underground cable systems. Ordinarily this phase of electrolysis would not be suspected, as tests between piping systems and rails would not indicate that such damage was going on.

Laying Service Pipes.

In laying service pipes, it is advisable to keep the pipes as far away from cable conduits as it is possible to do so, because there is no telling how the currents will flow along the pipes and pass out of them at any convenient point, and generally the point which is nearest the conduit is where the most of the current leaves. If the soil is of sand not much current will pass, but if it is wet clay, then a sufficient amount of current may pass to cause electrolysis corrosion.

The most valuable mitigative measure I believe that can be applied to pipe systems consists in the proper use of insulating joints. We believe the extensive use of such joints should be encouraged in new work and in making repairs.

There are many who criticize this method from the standpoint that current will flow around the joint and cause destruction of the pipe on the positive side of the joint. It is quite true that trouble of this character will arise and cause destruction of the pipe, provided the joints are indiscriminately placed without regard to their frequency, the kind of joints best suited to certain conditions, and the complication arising from the presence of other pipe systems not so insulated. All of these are important factors must be carefully taken into consideration if adequate protection is to be secured. It should be further understood insulating joints should be considered as an auxiliary in connection with and supplementary to measures to be applied to railway return systems for reducing stray currents to the lowest possible minimum. While it is not always possible to reduce economically stray current from the rails, it is nevertheless advisable to obtain data to show a fairly good idea of the nature and extent of stray current from the tracks.

As a general rule where a pipe line is laid with about every fourth or fifth joint an insulating joint, the line has such a high electrical resistance that no measurable current flows on the line, although considerable current exists in the earth parallel to the pipe line.

Placing insulating joints at too infrequent intervals is probably responsible for a good deal of disfavor of this system. Obviously if the joints are placed far apart, the long stretch of intervening pipe may pick up considerable current. Since this current must flow out of the pipe as it approaches the insulating joint, serious electrolytic corrosion may occur on the positive side of the joint. The more frequent the joints are placed, the less damage will occur from this source.

In these installations we find that it is necessary to install such insulating joints not only in the positive areas but also the negative areas where considerable current in the earth parallel to the pipe exists.

Installing Insulating Joints.

In connection with the installation of insulating joints on wrought iron and steel pipes. It has been found necessary to increase the length of the joint by surrounding the joint and pipe with a wood box, leaving a space inside to be filled with insulating compound. The length of the boxes depends upon the resistance and amount of current in the soil.

Enclosing insulating joints does not materially increase the resistance of the joints, but a long insulating

joint gives a more even distribution of leakage current than a short joint. A long insulating joint, therefore, is to be preferred when there is considerable potential across the joint or where the resistance of the surrounding soil is very low.

In a number of installations we found considerable current to flow around the joints, due to service pipes being in physical connection with gas services at the houses. This trouble was corrected by inserting an insulation joint at the service meter.

In some cases, however, it was found necessary to install an insulating joint in the service at the main and also a second joint at the meter. The necessary location of these joints must be determined from the results of electrical measurements.

We find the flanged type of joint the most desirable and economical joint to be used on wrought iron and steel pipes. This insulating joint has been made up of a disc of insulating material between the surfaces of the flanges, and placing insulating washers under the bolt heads and nuts. Red or gray fibre has most commonly been used for insulating material.

For cast iron water mains with bell and spigot joints we use a short wooden ring between the inside of the bell and the end of the spigot to prevent metallic contact between the pipe lengths, and then we caulk the joints with cement. The bead of the spigot end of the pipe was removed.

We find that the current in the pipe is considerably reduced by the use of cement joints. This, however, does not in all cases prevent electrolytic corrosion in localities where current can reach, as the pipe by way of laterals or where it is closely adjacent to other conducting structures or when there is leakage from another transverse pipe.

In the practical working out of the various systems of electrolysis protection, the conditions of the railway systems are usually ignored. I believe that a more logical and, at the same time, effective and economical procedure to handle the problem is first to obtain a general working knowledge of the railway systems, that is, a knowledge concerning the load factors of the various power stations, the operating time of each station, and a general knowledge of the leakage currents from the rails. From certain electrical tests it is possible to calculate the probable distribution of the leakage currents from the rails and to locate the places where there is a probability of electrolytic corrosion.

In order to obtain such information with any degree of accuracy, it is quite necessary that cooperation exist between the railway companies and owners of underground utilities.

ROAD WORK OPENING UP IN ALBERTA

TEN Alberta engineers in charge of the Provincial Government's program of road work for the coming season, have been sent out, and are now in the field ready to begin active operation as soon as weather and soil conditions will permit. Under the new system adopted by the department this year, there will be no more road foremen, and an entirely new code of instructions for the engineers and inspectors has been drawn up for application in the ten districts into which the province has been divided for road work purposes. The list of engineers is as follows: District No. 1, Geo. McMillan, Medicine Hat; No. 2, H. P. Keith, Lethbridge; No. 3, Malcolm Calder, Calgary; No. 4, Jas. McQueen, Hanna; No. 5, E. Ainsworth, Red Deer; No. 6, Ed. Robertson, Camrose; No. 7, J. A. Morrison, Vermilion; No. 8, H. S. Day, Edmonton; No. 9, D. Bard, Edmonton; No. 10, A. H. MacQuarrie, Peace River.

With a total of \$800,000 expended to date, another \$250,000 will be required to bring the commercial manufacture of Saskatchewan lignite to success. Of this additional amount, \$125,000 is required in cash immediately. In urging that the money be voted, officials of the lignite utilization board announced to the members in committee that they were on the eve of success.

BITUMINOUS SURFACES ON GRAVEL ROADS*

Refined Tar Products Give Satisfactory Results for Gravel Road Surface Treatment — Various Methods of Application Tried Out — Standard Practice Adopted

By Paul D. Sargent,

Chief Engineer, Maine State Highway Commission

FOR the last eight years the Maine State Highway Commission has been successfully treating gravel road surfaces with a refined tar product suitable for cold application. This method was adopted after an experience covering four or five years with various asphaltic oil and tar products. Where the two types of material were used on stretches of road contiguous to each other and conditions were as nearly identical as it would be possible to have them and both sections carried the same traffic, we found that the tar products gave a much more stable surface and that it lasted two to three months longer in the fall after freezing nights and thawing temperatures which prevailed during the daytime.

We also found that the tar products after being laid about a week took their set and with the exception of possible softening on extremely hot days, gave no further trouble after completion of the application. On the other hand, asphaltic oils would soften up many times during a protracted rainy period, more or less emulsifying, and resulting in a very disagreeable surface condition. This condition was also very marked during the period of freezing temperatures during the night and melting temperatures during the daytime, which prevail sometimes for three or four weeks in the fall.

It will be of interest to relate some of the experiences from which our standard practice in the surface treatment of gravel roads with bituminous material has been developed.

First Surface Treatments

Some eight or nine years ago when we first tried these treatments, the principal use of surface applications was to allay dust. Light asphaltic oil, known as "45 per cent oil" was generally used for that purpose. The real effect of the oil always appeared to be merely to load the dusty surface particles of the road with so much weight that when stirred up by passing traffic these particles did not rise very much above the road surface and consequently were not blown around much. Naturally, we more or less followed in our early tar applications, methods in vogue at that time. We attempted to get a true crown on our gravel roads by adding an inch or an inch and one-half of new gravel where necessary and then by the use of a drag or light grader truing up the surface before the application of the bituminous material. The first year this work was done on any scale, we applied our bituminous material in two applications. In May we used about four-tenths of a gallon to the square yard and about the first of August retreated all of these surfaces with an addition two-tenths of a gallon per square yard. Treatment was laid on a surface only 10 ft. wide. The real thing we sought to do with this treatment was to bond the loose surface material to the tightly bonded surface below it, and we accomplished this with satisfactory results.

By the end of the season, however, we observed that on certain sections of our roads so treated there was a slight rippling and waving of the surface. It occurred to us that this might be on account of the fact that we had not secured an effective bond between the loose surface particles of the road and the tightly bonded gravel beneath. In other words, the material which had been impregnated with tar had laid more or less as a mat upon the surface and not being sufficiently filled with mineral aggregate, had pushed.

We obtained, however, a much more satisfactory surface, generally speaking, than we had ever before seen on

*Paper read before the Eighth Annual Conference on Highway Engineering, Ann Harbor, Mich.

any surface treated road. The good sections presented the appearance of a first-class bituminous macadam surface, tightly sealed, smooth and dustless. As might have been expected, the edges of the bituminous treated section sheered off and crumbled away on account of so much traffic turning out for meeting and passing.

Next Development in Surface Treatment

Our next development was an attempt to clean the gravel surfaces before the application of the tar. This was accomplished by the use of graders and drags and later by using a street sweeper and finally by following that with hand sweeping. We also increased the width of our treatments to fifteen feet. We found that all these steps gave us a much improved surface and in fact since the first year we used tar we have never made but one application to any gravel surface during a season. No sand covering was used during our first two or three years of treatment. The tar was applied on warm dry days from an automobile tank distributor under pressure and we just allowed the tar to lie on the road until it was absorbed and took its set.

Needless to say, we had many complaints from the traveling public on account of the dangerous condition of a freshly tarred surface for rubber-tired traffic. We attempted to obviate this danger as far as possible by treating one side of the road at a time. We would do a considerable stretch of road, anywhere from six to ten miles long, and treat it on one side only. While the treatment was being put on the first side, the other half of the road was left open for traffic and by the time the first half was finished, the tar that had been first laid was well enough set so that the road could be used for traffic. Then the other half of the road would be treated in the same way.

We observed, of course, that steel-tired traffic wherever it ran on the freshly tarred surface, stripped the bituminous material from the surface. This made it necessary to do more or less patching by hand. Also, on account of the increasing automobile traffic, which was continually getting on the freshly tarred surface, we found it necessary to sand the tarred surface a few hours after application.

Recent Practice in Surface Treatment

For the last three or four years we have made a practice of treating all of our surfaces eighteen feet in width, which has practically obviated the necessity of any patching on the shoulders or edges of the treated surface. A road eighteen feet wide, which by the way is our standard width of pavements and hard surfaces today, affords a good double track way. We have been following the practice during the last three or four years of immediately covering the bituminous material with a light application of sand. By immediately, I mean that within five or ten minutes after the distributor has delivered tar to the surface of the road, it has been covered with sand.

There are one or two points about sanding that I think should be spoken of. We place the sanding gang at intervals of 150 to 200 ft. apart, according to the length of road that the tank of tar will cover. Immediately the tar tank has passed, sanding is started at the center of the road and first a place is made where passing vehicles may turn out on the freshly tarred surface. This affords traffic meeting places at stated intervals, so that with careful driving it is not necessary for a vehicle to become smeared or spattered with tar or to take the risk of skidding incident to driving on a freshly tarred surface. Our sanders are also instructed to keep an eye to the traffic so in case anyone gets into difficulty we will have some witness as to what actually happened. These men also more or less caution drivers to be careful. When we are applying tar over a summit grade we always plan to have a sander stationed at the summit to keep an eye to traffic and to warn them against collision. These points we have learned from experience and we have found them to pay.

Standard Practice Developed

Generally speaking we have developed the following standard practice: As early as we can get on the roads in the spring, that is, when the roads begin to settle and dry

out after the frost has left them, we begin shaping with the road grader. The roads are carefully watched during the two or three weeks while they are settling and are shaped either with a drag or blade grader several times if necessary to help them to settle with as true a contour as possible. The next step in our surface treatment is to draw out sand, which is left on the shoulder of the road in piles of about a quarter of a yard every twenty-five feet. Generally speaking, we use about fifty yards of sand to a mile for cover. We use less sand, however, on a brand new treatment than we do on re-treatment. Sometimes as little as thirty yards to a mile is used on the original treatment. Re-treatment will take from forty to fifty yards per mile, as the tar has less opportunity to penetrate into the surface of the road. The next step is to clean the surface of the road of all loose material. If a pocket of sand, dust or stone is left on the surface we are absolutely sure to have the treatment break over that pocket in a short time after application.

This cleaning is done by means of a street sweeper behind a light truck and if further cleaning is necessary after the sweeper has finished, it is done by men with push-brooms. Then comes the tar distributing gang, which is equipped with Kinney pressure distributors mounted on $3\frac{1}{2}$ -ton trucks. We have limited ourselves to this size of equipment because it is as heavy as our roads, generally speaking, will carry. We have a law which limits the gross weight of load to 9 tons, and I am free to say that one of these 600-gal. tanks filled with bituminous material will slightly exceed the statutory limit for the gross weight of load. Under average conditions one tank truck will spread about 2,500 gallons of tar per day. We still hold to the practice of tarring one side of the road at a time and several days may elapse between the tarring of the first side and the tarring of the remainder of the road. As pointed out above, immediately after the tar is applied a light sanding is given. We put on just enough sand to fairly blot the bituminous material and keep it from running off the crown of the road to the edge. The surface is carefully watched for three or four days and if evidence of bleeding shows up, spots where this occurs are treated with more sand. Sometimes after a treatment has been down for two or three weeks an extremely hot day will start a little bleeding. This is watched carefully by the patrolman and the same treatment of light sanding given.

Treatment of New Gravel Surfaces

In the treatment of new gravel surfaces, that is, surfaces which have never received a treatment before but which may have taken traffic anywhere from two to four or five years with an occasional resurfacing of gravel, we used not to exceed half a gallon per sq. yd., and in some cases probably use four-tenths to forty-five-hundredths of a gallon per square yard for the treatment. The amount of material depends upon the tightness of the surface. We have found that the smallest quantity of material we can use and get the surface covered gives us the best result. With a small quantity we never have trouble from rippling or waving of the surface, provided the gravel is in proper shape to receive the treatment when it is given, that is, thoroughly bonded and tight with no pockets of loose gravel, dust, or other material. We also find that surfaces which have received a small quantity of tar can be re-treated for a longer time than surfaces which have been given a heavier treatment. Those which have received the heavier treatments will ripple and get out of shape, say in two, three or four years, while sections receiving a light treatment can be maintained without breaking up for a considerably longer time.

It must be borne in mind that the addition of the bituminous surface treatment to a gravel road does nothing but preserve the surface against disintegration from passing traffic. It does not materially strengthen the road in the sense that it will cause the road to take heavier loads than the gravel surface itself or the foundation upon which it is laid will sustain. Surface treatment will not supply or take the place of drainage.

Our surface treated sections are kept under constant patrol maintenance. We patrol these roads with a light truck and two men, and they are assigned sections anywhere from 12 to 18 miles long. Besides watching the bituminous surface and mending any small breaks that may occur, and we have these breaks occasionally, and patching the shoulders, these men also keep the dirt shoulders shaped by dragging, keep the gutters and culverts clear, and do whatever other work is necessary. We supply about three barrels of bituminous material, for each mile of surface, the material being mixed with sand and kept in stock piles. The mixing is usually done by hand and we use about 17 gallons of tar to a cubic yard of sand. In a few instances we have used a small concrete mixer to prepare the tar and sand for patching and we have been able to use as little as 14 gallons to a yard of sand when the mixing is done in a concrete mixer. Patches are made by simply cleaning out the hole, throwing in the mixture of bituminous material and sand and patting it in with a shovel. Any bad breaks on the shoulders are repaired the same way.

Many of our gravel treated surfaces do not remain intact over the spring period, a good deal breaking up, which is due to several causes. First an open winter which allows the frost to penetrate deeply into the roadbed and permits traffic to run all through the winter, or heavy traffic coming on these surfaces when the frost is leaving and the surfaces being soft, will break up and often disintegrate. This really is more or less of an advantage, because it obviates the necessity of breaking up these surfaces and we save just that much expense in getting the surface ready for subsequent treatments. I have in mind one section of gravel road which was surface treated during the summer of 1920. Most people called it a good section of road, in fact many automobilists have referred to it as bituminous macadam and many of our citizens refer to our surface treated gravel roads as bituminous macadam. The particular section I refer to was so bad during March, 1921 that automobiles could not pass over it. For a distance of four or five miles, this piece of road was literally a sea of mud for a period of about three weeks. Of course the surface treatment completely disappeared. We reshaped the road as it dried out and re-treated it last spring. It presented a good surface all through the summer and fall until it was covered with snow. I apprehend that the coming spring will be a repetition of the spring of 1921. The road will be in about as bad condition as it was then but by June 15, it will look like a boulevard.

On the other hand, I have in mind one section of surface-treated gravel road which is built on a sandy foundation where the drainage is perfect that has never broken up during the last eight years. It gets a re-treatment about every other year, maybe one-sixth or one-seventh of a gallon, as the gang goes by, and during the intervening year it does not get treated. This particular section shows evidence of slight ripples. It is on our heaviest travelled line, where the snow leaves earliest in the spring and we have the most severe truck traffic in the State.

Re-Treatment of Good Surfaces

We have a good many sections of surface treated gravel roads which do not break up in the spring, most of these sections being re-treated each year. The second year the amount of tar which we have used has been from three-tenths to one-third of a gallon per square yard. For the third and fourth years the amount has run as light as one-quarter of a gallon, and in some instances two-thirds. These surfaces are quite apt, however, after three or four re-treatments, to become ripply enough so as to be uncomfortable to ride over, this condition being due to a combination of reasons. One is that we may have as much as one and one-half or two inches of tar penetration which becomes separated from the gravel road itself on account of the passage of heavy loads when the frost is coming out of the ground and the whole roadbed is more or less soft. Where this tendency exists at all it is always more pronounced where the surface has received successive treatments than where only one or two treatments have been given. Each year we have to break up more or less of this kind of surface

and get the road in shape for new treatment. The method used is approximately as follows: We take a section of road about 1000 ft. long; it is broken up either by using a pressure scarifier on a steam roller or by using a heavy blade grader behind a truck or a roller and setting the blade so that it will do more of a plowing operation than a scraping one. The bituminous surface is in this way broken up into chunks anywhere from two inches to two or three feet square. We next take a road grader and scrape this whole surface off to the shoulder of the road, then we plane the roadbed below to as true a surface longitudinally and transversely as possible. We then work back a portion of the bituminous bound material from the shoulder, distributing it over the surface.

In this distributing operation the bituminous bound gravel is broken up more or less into small chunks. We then leave the road for two or three days for traffic, which materially helps to further break up these pieces of bituminous bound gravel, then the road grader is brought on and further working of the surface is given just by pushing the chunks around and pulling in more from the sides. By watching the surface carefully and using the road grader every two or three days we have been able to get the surface back into reasonably smooth condition. It presents more or less of a mottled or mosaic appearance. Gravel which has been covered with the bituminous material has lost its binding property and it is necessary quite often to add a bit of good binding material here and there to complete the bonding of the surface. This binding material is used sparingly. As soon as we have the surface in shape we give it a new application of tar. We find that a surface broken up and reshaped as just described is very hard to keep in true contour under traffic and if it is allowed to go say two weeks, we may have to break it up and rebind it before the tar surface is applied, otherwise it would be so uneven that it would be a bad riding road all through the season. Experience has shown that one of these old tar surfaces can be scarified and broken up more easily when the temperature is between 60 and 70 degrees F. than during cooler weather. Good warm, sunny weather also materially assists in breaking up the chunks of tarred gravel which are left on the surface of the road.

One thing we have satisfied ourselves on is the fact that we cannot successfully apply tar surface treatment on a wet or damp road. We have also had the experience of rain falling within two or three hours after tar has been applied and before it has taken any set, and with a traffic resulted in making a mushy surface which it is practically impossible to true up and make satisfactory. We have practically come to the conclusion that when this condition prevails we would do better to scrape the new tar surface right off on the shoulder, throw it away, reshape our road and put on a new application of tar. We will spend more money in patching the surface which is laid under these conditions than it would cost to replace the surface, and such surface after patching has never been satisfactory.

During the last four years our surface treatment work, plus the cost of patrol maintenance, for a season of eight months has averaged to cost \$1,000 per mile. We estimate sand to cost us an average of \$2.00 per cubic yard delivered in piles alongside the road. Tar costs us 12 cents in tank cars delivered on the nearest railroad siding. We figure the cost of applying the tar at 2 cents per gallon. Sanding costs about 75 cents per cu. yd. of sand. Using say 4,000 gallons of tar per mile would cost \$560.00; fifty yards of sand will cost \$100, applying the sand \$37.50, making the cost of the tar treatment covered with sand \$697.50.

Cost of Surface Treatments

The average cost of shaping and getting the surface ready for treatment in the early spring would be about \$25 per mile. We use ordinarily a 2-ton truck to draw the road machine. The truck rental would be \$10 per day, the driver's pay \$3.75 and a helper \$3. The rental of the road grader is figured at \$2 per day, while gas and oil will

run from \$5 to \$6 a day. This outfit will smooth four miles per day on an average, usually on the first smoothing we make about four round trips per mile. On subsequent smoothings possibly two trips will do.

For sweeping we use a mechanical sweeper drawn by a light truck say $\frac{3}{4}$ -ton or a one-ton truck. We usually make four round trips with the sweeper, and this outfit will sweep about two miles per day, as we can only run the sweeper about three miles per day. The expense for sweeping would run about as follows:

Truck rental \$5; oil and gas \$2; driver \$3.75; helper \$3; rental of sweeper \$2; making a total of \$15.75, an expense of sweeping two miles of \$7.87 per mile.

The balance of the \$1,000 is paid for patrolling the road through the season. The usual patrol gang on bituminous surface treated gravel roads is a patrolman with a one-ton truck and helper. According to the amount of traffic and the condition of the road, this outfit will cover anywhere from twelve to eighteen miles of road. The outfit costs \$13.75 per day, made up as follows: Rental of one-ton truck \$5.00; gas and oil \$2; patrolman, who drives the truck \$3.75; helper \$3.00. These gangs work an average of two hundred days per year, so if the patrol section was 13 $\frac{1}{2}$ miles long the average cost per mile would be just \$200.

Based on the figures given above, this would show a maintenance cost of \$930.37 per mile. I have said that on new roads we use half a gallon of tar per square yard. That will increase the cost \$140 per mile over the figures already given.

Where it is necessary to scarify or break up the old bituminous surface, we run into a considerably larger expense for preparing the surface than indicated above. I think I have given enough explanation, however, to show that the average cost is very close to \$1000 per mile.

There is one point that I neglected to mention and that is that quite often in making an original treatment if traffic is running fairly heavy and it will take us six or eight days to treat the section we are working upon, we will slide over the road with a priming coat of the tar material, using two-tenths to one-quarter of a gallon per square yard, the quantity depending upon the tightness of the surface. This will hold our surface in perfect condition under traffic for a week or ten days. We immediately apply the balance of the quantity, sand, and finish up the job. We have almost come to the conclusion that it would be good practice to do the priming everywhere on new surfaces. It gives a better penetration of the bituminous material, besides holding the surface in proper contour until the treatment can be completed.

In conclusion I might say, that we have many miles of surface treated gravel roads which are carrying a twelve-hour traffic, averaging from 2,300 to 3,500 vehicles per day for a week's time, with a maximum traffic during the twelve-hour period of as high as 5500. This traffic continues for a period of four to five months. We find it impossible to hold our gravel surfaces in satisfactory condition by ordinary patrol maintenance methods, that is, dragging and patching with gravel, when the traffic exceeds 500 to 600 vehicles per twelve-hour day, and the expense of such maintenance runs about \$500 per mile.

The material which we use for surface treatment falls within the specification T. C-1, tar for cold application. Bulletin No. 691, U.S. Department of Agriculture. Credit for the most of the developments we have made in surface treatment of gravel roads is due to A. J. Wiggin, Superintendent of Maintenance of the Maine State Highway Department.

Announcement was made recently of the formation of the Hochelaga Cement Company, Limited, with plant in Montreal, and authorized capitalization of \$4,000,000 preferred. The new company, which is planned to meet requirements in Quebec and also for export, has been formed by Montreal interests, and its organization has been effected by Credit Canada, Limited, investment bankers. Capacity of 750,000 barrels a year is aimed at with expansion up to 5,000 barrels a day in the future.

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MODULAR RATIO UNDER FIRE

EVIDENCE that there is not yet entire agreement with respect to the fundamentals of reinforced concrete design is contained in frequent papers and communications to the technical societies and press on matters about which it has been assumed by many that finality had been reached. One of these dissenting papers is the notable one by H. Kempton Dyson before the Concrete Institute, an abstract of which appears elsewhere in this issue.

Mr. Dyson questions very much the soundness of the common theory of reinforced concrete, in so far as it is based on the modular ratio. In his opinion a reinforced concrete beam is by reason of the inevitable cracking on the tension side resolved into a virtual truss and that it should be figured as such. The action so assumed must of necessity be based upon a thoroughly effective anchorage at each end of the tension steel, since the concrete encasing the steel in the central portion of the beam is very much in the position of a set of idling washers. There are a good many designers who are in agreement with Mr. Dyson with respect to the absolute necessity for a thorough anchorage at each end.

Apparently the revolutionary views that have recently been brought forward with respect to the action of concrete columns are shared by British engineers. Mr. Dyson does not appear to experience any alarm over the surprising fact that stresses in longitudinal reinforcing steel in columns after a few years may be considerably over the yield point. In this he is in agreement with Franklin R. McMillan who frankly accepts this condition of affairs on the apparent ground that columns designed by the common

theory however faulty have been shown to be safe, and that such stresses as actually exist in them may be accepted as satisfactory. Mr. Dyson takes a somewhat different view from that advanced by Mr. McMillan in that he would entirely ignore the ratio of the moduli of elasticity and compute the total resistance of the column as the sum of the two individual resistances of the concrete and steel, the steel rods being constructed as a series of short columns.

Such questions as have been raised by Mr. Dyson and other investigators are sure to bring about important modifications in reinforced concrete specifications. While the common method of figuring concrete beams will probably continue to be followed on this continent, the design of columns is undergoing a change. As an example of this, there may be cited the entirely new specification for reinforced concrete columns of the Joint Committee.

HAULAGE OF CONCRETE FROM CENTRAL MIXING PLANTS.

SOME time ago attention was drawn in our editorial columns to the growing practice of mixing concrete for roadwork at central mixing plants and hauling it to the point of use in motor trucks. A notable instance of success by this method was in work done on the California State Highway system in the Imperial Valley where a haulage requiring 25 minutes of time occurred.

Caution must, of course, be exercised in carrying out this method to insure that the concrete has not lost strength appreciably through initial setting. Even though such has occurred to some extent, the mixture may be useful, as investigation has shown that concrete may be remixed with little or no loss of strength up to the third hour after the original mixing. Another source of possible trouble is in the segregation of the aggregate which it has found may be prevented, in some measure at least, by the use of hydrated lime.

Recent tests made by the United States Bureau of Public Roads indicate that a considerable time may safely be allowed to elapse between mixing and use without appreciable loss of strength. Gravel concrete of 1:1½:3 mix was hauled in trucks and the material tested at periods of elapsed time varying from 15 minutes to 3 hours and 10 minutes. It was found that the average crushing strength of cylinders was very nearly the same for all specimens, but that the workability diminished markedly after the first hour. Apparently, the practicability of the method would depend upon workability rather than strength, as after 45 minutes the mixture was too dry for hand finishing, although it might have been used up to 2 hours of elapsed time with a pavement finishing machine. It thus appears that so long as concrete is workable after hauling, its strength would be sufficient, and that the most practicable way of utilizing concrete hauled from a central mixing plant is to employ a machine finisher. For road or street work where it is impracticable to mix concrete at the point of use this method has become very promising.

PERSONALS

R. O. SWEENEY has been elected president of Queen's University Alumni Association of Montreal.

HENRY J. SPOONER, who has been head of the Polytechnic School of Engineering, Ottawa, for 40 years is retiring in July.

H. A. TERREAU, superintendent of the aqueduct department, Montreal, has been appointed Director of Public Works for Montreal.

ARTHUR WILLIAM CARLYLE, Ottawa, has been appointed Leroy Fellow in Geology at McGill University for 1922-23. He is a third year graduate in geology with honors.

A. L. LATORNELL, engineer of sewers, Department of Works, City of Toronto, has tendered his resignation to

R. C. Harris, Commissioner of Works, and it has been accepted. Formal announcement of the name of Mr. Latornell's successor will be made at an early date.

R. C. MUIR, chief engineer of county roads in Ontario, has been spending a few days in Ottawa at the invitation of the Ottawa Suburban Road Commission, to inspect the roads after the winter's frost and also to advise the commission in regard to details of the work planned for the summer.

LT. COL. H. L. TROTTER has entered private practice as consulting engineer, with offices in the New Birks Building, Montreal. Col. Trotter was until recently construction engineer at Iroquois Falls, Ont., for the contracting firm of Morrow & Beatty, Ltd., Peterborough, Ont. He is a graduate of the Royal Military College, Kingston.

OBITUARIES

ROBERT SLACK, a well known contractor and builder of Ottawa, died suddenly May 6, aged 66.

E. NORMAN, builder and contractor, Yorkton, Sask., for many years connected with the firm of Dryborough and Norman, died suddenly at the age of 37 years.

CHARLES M. TEASDALE, of Toronto, Dominion Land Surveyor, died recently at Flin-Flon, Man., aged 40 years. The deceased graduated with honors from the University of Toronto in 1904, and after graduation practiced his profession in the West in the employ of the Dominion Government. For the past five years he has been located in The Pas district of Manitoba. His last location was the Flin-Flon Copper Mine. He prepared a large number of maps of Western Canada districts.

Engineer's Library

NOTABLE TREATISE ON BRIDGE ECONOMICS

Reviewed by H. M. MacKay,

Professor of Civil Engineering, McGill University.

ECONOMICS OF BRIDGEWORK: A sequel to Bridge Engineering—By J. A. L. Waddell, D.Sc., LL.D., etc., Consulting Engineer, New York; John Wiley & Sons, Inc., London; Chapman & Hall, Ltd., Cloth; 6 by 9 in.; pp. xxxii + 512; illustrated \$6.00 net.

This book is in effect a sequel to the monumental work on Bridge Engineering published by the same author a few years ago. In the present work the author has undertaken to solve in a comprehensive way the major problems of an economic nature arising in the whole field of bridge construction. At the outset economics is defined as the science of obtaining the desired result with the minimum expenditure of effort, money and material.

Many writers have investigated economic problems arising in bridge construction in a purely mathematical way. The results are seldom satisfactory. Even formulae for quantities alone, so obtained, are usually too intricate and cumbersome for practical use unless the assumptions on which they are based are greatly simplified, in which case empirical formulae are likely to give quite as good results. Besides, of course, even in steelwork, minimum quantity of material and minimum cost are by no means identical. Considerations affecting convenience of fabrication, shipment and erection; variations in the price of certain shapes and sections; the incidence of certain clauses in the specifications and the like, all tend to complicate economic relations and to make the results of narrow theoretical reasoning misleading. In the case of concrete construction this is true to an even greater degree.

In this work the author has for the most part avoided purely mathematical treatment. The typical method of solving the various problems is by means of estimates from

a graduated series of designs, the results of such computations, shown graphically, indicating the conditions of greatest economy. While this method has involved an immense amount of labor on the part of the author, it enriches the book with a large amount of useful and suggestive data. In the case of the more ordinary class of structures the curves of weight and quantity are in close agreement with the best modern examples as built, and will command entire confidence. On the other hand, certain long span cantilever bridges, the Beaver bridge and the Quebec bridge for instance, considerably overrun the weights indicated by the author, for similar structures. Such discrepancies are no doubt inevitable in the case of exceptional structures, but a word of caution to the hasty reader is perhaps desirable.

Among the topics of more general interest, to each of which one or more chapters is devoted, are: The Comparative Economics of Bridges vs. Tunnels; High vs. Low-level Crossings; Steel vs. Reinforced Concrete Structures; Riveted vs. Pin Connected Spans; Continuous vs. Non-continuous Spans; and Cantilever vs. Suspension Bridges. The Economics of Alloy Steels, Layonts, Substructure, Trusses and Girders, Floor Systems, Reinforced Concrete Bridges, Steel Arches, Trestles and Viaducts, Cantilevers, Suspension Bridges, Moveable Spans, Shopwork, Erection, Fieldwork, Floor systems, Maintenance, Waterproofing and many other topics are fully treated. Several of the above topics are discussed by well known specialists as well as by the author, a feature which makes for breadth of view.

Special mention may perhaps be made of the chapters on Steel Arches and on Alloy Steels. Both of these embody the results of a very large amount of investigation. Little information has hitherto been available on the former subject, and the conclusions reached should be very useful to the designer. As regards alloy steels it may be questioned whether the author attaches enough importance to the greater deflections of structures wherein they are used, with the possible consequences in the way of impact and secondary stresses.

The style as in all of Dr. Waddell's writings is clear and interesting. No mere catalogue of topics can give an idea of the amount of stimulating suggestion which is found in every chapter. The author's views often provoke controversy, but it is safe to say that the book will be found indispensable by everyone interested in bridgework.

Many readers will note with regret that the author puts this work out as his last book. Those whose memories reach back thirty years or more, will remember Dr. Waddell as the protagonist in many a well fought controversy, and often in the face of keen opposition, of numerous ideas which are now accepted as the common places of good design. No living engineering writer, it may be believed, has given more freely or more effectively to his professional brethren the fruits of a long and successful experience than has this Canadian born author.

PORTLAND CEMENT ASSOCIATION, ITS CHARACTER AND PURPOSES—By Lester T. Sunderland, president of the association; 4-page pamphlet, 5½ by 8½ in., issued by the Portland Cement Association, 111 West Washington St., Chicago, outlining the objects, aims and ideals of the association.

HARDINGE CONICAL MILLS—Bulletin issued by the Hardinge Co., 120 Broadway, New York, describing conical ball and pebble metal mills for grinding and pulverizing; 4 pp., 8½ by 11 in., illustrated.

ASPHALT PAVING INSPECTION—Circular No. 17 issued by The Asphalt Association, 25 West 43rd St., New York City; 4 p.p., 6 by 9½ in. Article by W. Earl Weller, city engineer, Wilmington, N.Y.; illustrated by four figures reproducing inspector's daily report form, load report form and asphalt laboratory report form.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders	
	Close	Issue
Chatham, Ont., construction of concrete pavement	May 17	May 9
North Oxford Tp., Ont., construction of concrete abutments for bridge, also building of grade to bridge....	May 27	May 9
Saskatchewan, Province of, construction of earth road to Wadena.....	May 23	May 9
York Tp., Ont., concrete sidewalks.....	May 20	May 9
Toronto, Ont., installation of one four-million Imperial gallon centrifugal pump at Island Pumping Station....	June 13	May 9
York Tp., Ont., construction of cast iron watermains	May 20	May 9
Hamilton, Ont., erection of school on Bowman St., West Hamilton.....	May 17	May 9
Woodstock, Ont., erection of Bell Telephone exchange building.....	May 18	May 9
Dungannon, Ont., construction of overflow drain	May 24	May 9
Hespeler, Ont., erection of Sons of England Memorial Hall	May 20	May 9
Ottawa, Ont., various work on Civic Hospital	May 25,	
	30, June 1	May 9
Sylvania, B. C., erection of school	May 23	May 9
Waltham, Ont., construction of dam.....	June 1	May 9
Palmerston, Ont., construction of pavement	May 22	May 9
Quebec, Province of, macadamizing of Levis-Jackman highway	May 29	May 9
St. Malachie, Que., construction of metallic bridge	May 23	May 9
Saskatchewan, Province of, construction of concrete bridges	May 29	May 9
Sherbrooke, Que., construction of pavement and concrete sidewalks	May 22	May 9
Nassau, New Providence, Bahamas, dredging	July 15	May 9

BRIDGES, ROADS AND STREETS

Aurora, Ont.—Boards of Trade of Newmarket and Aurora and W. A. McLean, Deputy Minister of Provincial Highways, will confer here with the Yonge Street Highways Improvement Association, with a view to increasing the proposed width of Yonge St. from 86 feet to 100 ft. Property-owners from the city limits of Toronto to Lake Simcoe will be represented. The Ontario Government has called for tenders for the construction of five miles of roadway north of Toronto's limits, and it is expected that a start will soon be made on the work.

Birch Cliff, Ont.—Scarboro Township Council passed by-law authorizing an expenditure of \$39,000 on road construction this year and \$26,500 on road maintenance. Concrete sidewalks will be constructed on both sides of Eastwood Ave. There are now about six miles of sidewalks under construction.

Blenheim, Ont.—Provincial Department of Highways awarded contracts in connection with improvement of Talbot Road as follows: Four miles west from the Harwich and Howard townline to John Clayton, of Harwich, and Alex. Clunis, of Blenheim; four miles west of this and also a division east, to Webster Construction Co., of London.

Brantford, Ont.—Contracts for annual supplies for city were awarded as follows: Asphalt, The Sun Co. of Canada, Ltd., Toronto; road oil, W. C. Brennan Contracting Co., Hamilton; and Portland cement, Alfred Rogers Co., Ltd., Toronto.

Clarkson, Ont.—Toronto Township Council plans to resurface Streetsville road this year and general grading work will be done on other thoroughfares. Clerk, C. H. Gill, Dixie, Ont.

Edenwold R. M., Sask.—Tenders addressed to W. H. Davis, Sec.-Treas., Zehner, Sask., will be received until 6 p.m., June 5, for all or parts of the following work: 40 miles new turnpiling and regrading, 30 miles very light regrading, 11,000 cu yds. filling and 500 lin. ft. culverts. Plans and specifications may be seen at the office of the Municipal Engineers, Parsons Engineering Co., Regina, and at the office of the Secretary-Treasurer.

Elgin County, Ont.—Contract for grading Silver Creek Hill awarded to J. H. Miller, Dutton. Approximate quantity of excavation, \$13,000 cu. yds.

Fort William, Ont.—Tenders closed May 15 for approximately 400 rods of road grading. City Engineer, C. B. Symes.

Galt, Ont.—Grand River Railway has been asked to approve of a plan suggested by K. K. Homuth, M.P.P., for a boulevard drive between Galt and Preston.

Galt, Ont.—City Council intends to construct an asphaltic concrete pavement 10 ft. wide, on the north side of Main St., from Elgin St. to City Limits, at a cost of \$3,300. City Clerk, Joseph McCartney.

Guelph, Ont.—Tenders closed May 11 for construction of concrete sidewalks. City Engineer, F. McArthur.

Hamilton, Ont.—Hon. F. C. Biggs, Provincial Minister of Public Works, announced the following road building program for this district this season: Main Street Road from the city limits to fork of King and Main just below Stoney Creek, Main Street Road from the fork to Winona P.O., five miles; Hamilton-Brantford Road, unfinished portion between Ancaster Village and the county line; foundation work on the Hamilton-Galt Road in Wentworth County to be finished this year; three miles of surfacing from Clappson's Corners to Black's Corners; foundation work on the Dundas Road from Clappson's Corners through Waterdown to the County Line; finish the foundation work on the Hamilton end of the Hamilton-Toronto highway; three miles of foundation work on the Caledonia Road south of the three miles completed last year. It was promised that the top dressing of the Caledonia Road from the Mountain top to Ryckman's Corners would be built, but the work is not included in the construction program.

Hartney, Man.—No contracts were let by the Municipal Council for grading of 9 miles of road and also for the manufacture of concrete pipe culverts required on 38 miles of roads, for which tenders were called. Council decided to drop all work, having failed to receive any assurance of aid from Provincial funds.

Kingston, Ont.—City Council intends to construct concrete walks on the following streets: Adelaide, Alfred, Birch, Earl, Johnson, Macdonnell, Ontario and Thomas, at a total estimated cost of \$6,484.10; also sheet asphalt pavement on Montreal St., at cost of \$4,101.02. City Clerk, W. W. Sands.

Kitchener, Ont.—As only one tender was received by city for bituminous penetration pavement, for which tenders closed May 8, no contract has been let, and it is probable that the work will be done by day labor. Contract for approximately two miles of sidewalk was let to Carl Damman, of this city, and contract for curb and gutter for bituminous penetration roadways was let to B. J. Mickel.

Lindsay, Ont.—Contract for construction of granolithic sidewalks during 1922 was awarded to Geo. H. Lindsay, of this town.

Mimico, Ont.—Town Council is about to issue calls for tenders for construction of roadways. Clerk, J. A. Telfer.

Prince Edward Island, Province of.—Provincial Legislature authorized borrowing of \$450,000 for road building under the provisions of the Dominion Highways Act.

Quebec, Province of.—Work will start this year on important sections of the Levis-Riviere du Loup Road. Minister of Highways, Hon. J. L. Perron.

Quebec, Province of.—Hughes Fortier, M.L.A., for Beauce, had an interview recently with Hon. Mr. Galipeault, Minister of Public Works, in connection with the construction of a bridge on La Famine river.

Quebec, Province of.—A delegation of representatives of the County of Montmorency waited on Premier Taschereau recently in connection with the construction of the Quebec-Ste-Anne Highway. Premier Taschereau announced that the road would certainly be built and that plans are now being prepared.

Quebec, Province of.—Tenders will be received until 1 o'clock p.m., May 30 at the office of J. L. Perron, Minister of Roads, Parliament Bldgs., for the resurfacing of macadam on the Montreal-Ottawa highway within the municipalities of the village of l'Abord-a-Plouffe, of the parish of Ste. Dorothee and of the west part of the parish of Ste. Rose (about 62 miles).

Queenston Heights, Ont.—Contract awarded by Queen Victoria Niagara Falls Park Commission to Bennett and Lovejoy, of Toronto, at \$29,500, for construction of 4,100 ft. of macadam roadway 24 ft. wide. There were five other tenders submitted.

Riverside, Ont.—Tenders closed May 10 for construction of 1,300 ft. concrete sidewalk on Clairview, Elinor and John M.; 1,589 ft. sidewalk on Lauzon Road; 2,231 ft. of concrete sidewalk on St. Louis Ave. Clerk, C. J. McHugh, Ford, Ont.

Rockland, Ont.—Contract for construction of about 2,500 lin. ft. of bituminous roads on Main St. was awarded to McDonel & Dibble. Approximate amount of contract, \$16,000.

St. Catharines, Ont.—Tenders will be received, addressed to the Chairman, Board of Works, City Hall, until 5 o'clock p.m., Thursday, May 25, for the construction of approximately: 10,000 sq. yds. concrete foundation for pavements, including curbs and gutters; 6,000 sq. yds. cement concrete pavement; and 9,600 lin. ft. of concrete sidewalks. Plans and specifications on application to City Engineer, W. P. Near.

Saskatchewan, Province of.—Tenders will be received by H. S. Carpenter, Deputy Minister of Highways, Regina, until 12 o'clock noon, Tuesday, May 23, for construction of earth road from North of Watson to St. Gregor. Plans and specifications may be seen at the office of H. S. Carpenter, and at the office of W. Grant, 810 Canada Building, Saskatoon; J. R. Reid, Court House, Swift Current; W. T. Smart, Watson, Sask.; and F. G. Klusack, Dominion Grain Co., North Battleford, Sask.

Swan River, Man.—Tenders close May 16 for construction of approximately 6,200 sq. yds. of concrete sidewalks. Sec. Treas., A. E. Reed.

Sydney, N.S.—Tenders will be called by Board of Works for construction of Argyle St. bridge, estimated to cost \$7,500. An expenditure of \$1,500 on Townsend bridge is proposed.

Toronto, Ont.—Toronto Harbor Commission has made a request to the Board of Control that the city make appli-

cation to the Board of Railway Commissioners for an order permitting the construction of a new bridge over the railway tracks at the foot of Spadina Ave.

Welland, Ont.—Tenders will be received until May 24 by W. A. Swayze, Chairman, Welland, for the construction of 2½ miles of bituminous penetration road in Township of Crowland and 2 miles in the Township of Thorold and on the Peiham-Thorold Township line. Plans and specifications may be seen at the office of W. W. Brookfield, Box 1334, Welland, County Road Superintendent.

Welland, Ont.—Welland County Council awarded contracts for 9-ft. waterbound macadam road construction as follows: Three miles in Crowland Tp. to John Pirson, at \$8,490 per mile; 1¼ miles in Humberstone Tp. to R. G. Law, at \$6,000 per mile; 2 miles in Thorold Tp. to John Pirson, at \$8,490 per mile; 1¼ miles in Stamford Tp. to the Duferin Construction Co., at \$7,500 per mile. To Archibald Construction Co., 1¼ miles of 16-ft. waterbound macadam road in Pelham Tp. at \$13,990. If the Good Roads Committee can effect satisfactory arrangements with the latter contractor for an asphalt surface at an addition cost not to exceed \$1,750 per mile, this surface will be adopted. To E. G. Law, 2 miles in Bertie Tp. at \$15,750 per mile for a 16-ft. bituminous penetration paving with asphalt surface. Contract for 5 miles in Wainfleet Tp. was held open. Tenders were submitted for a 9-ft. road, but it is expected that this will be made a County-Provincial road at 16 ft. Action was deferred until June session of Council. Two tenders were submitted for a 9-ft. waterbound macadam road in Pelham Tp. Council considered tenders too high and the clerk was instructed to readvertise this, tenders to be considered at June session. Imperial Oil, Ltd. and Sun Co. of Canada, Ltd., submitted tenders on road oil. It was decided to ask bids covering the oil applied to the roads, and this matter also will be disposed of next month.

Woodstock, Ont.—By-law passed to construct a concrete curb and gutter on Oxford St., from Dundas to Drew, and a concrete sidewalk on the south side of Anne St., from Norwich Ave. to Maud St. Clerk, John Morrison.

WATER, SEWAGE AND REFUSE

Becton, Ont.—Village Council is issuing debentures amounting to \$6,000 for water works improvements. Clerk, Joseph Wright.

Crystal Beach, Ont.—Following tenders were received for 4,050 ft. of sewer and a 350,000 gal. per day Activated Sludge Disposal Plant; H. M. Balfour, Welland, \$56,228; F. F. Fry Co., Toronto, \$59,578; Central Foundation Co., \$59,799; Louis Sacco, \$60,500; Andrew Elsher, Niagara Falls, \$61,500; Robertson Construction & Eng. Co., Niagara Falls, \$65,000; MacNamara Bros., Sault Ste. Marie, \$65,947; Reid & Somers, Toronto, \$67,414; Canadian Engineering Const. Co., Hamilton, \$79,700; Flanagan Co., Fort William, \$79,990.

Dunnville, Ont.—Contract has been awarded to Turbine Equipment Co., Ltd., Toronto, to supply and instal one 150-h.p. motor-driven pump, one 150-h.p. gasoline engine, one 40-h.p. motor-driven pump, one 10-h.p. motor-driven pump, and one 25-h.p. combination gasoline-engine and motor driven pump. The gasoline engines will be supplied by the Sterling Engine Co., Buffalo, and motors by Canadian Crocker-Wheeler.

Dunnville, Ont.—Following tenders were received for a 1,200,000 gal. filter plant and equipment; Building only-Taylor Construction Co., \$22,900; Canadian Engineering & Construction Co., \$23,000; Pigott & Healey, \$24,900; Schultz Bros., \$25,500; W. H. Yates Construction Co., \$25,777; A. C. Stewart & Sons, \$26,548; F. F. Fry Co., \$27,976; Robert Bennett, \$33,340; Reid & Somers, \$34,523; and Somerville & Dilworth, \$35,790. Filter equipment only—Roberts Filter Co., \$11,779; Permutit Co., \$13,386; International Filter Co., \$14,785; New York Continental Jewel Filtration Co., \$14,891; Pittsburgh Filter Co., \$15,061. Combined tenders—Canadian Engineering & Construction

Co., \$35,900; R. L. Smith & Co., \$44,508. Pumps installed, Arthur S. Leitch, \$20,285; Turbine Equipment Co., \$20,950; Canadian Fairbanks Morse Co., \$20,313; Goldie & McCulloch Co., \$20,381; London Concrete Machinery Co., \$21,510; Storey Pump Equipment Co., \$22,454; Canadian Ingersoll-Rand Co., \$24,618. Pumps only—Clayton, Neil & Jones, \$14,135; Canadian Allis-Chalmers Co., \$14,590; S. B. Whiney, \$14,661; Canadian Blower Forge Co., \$15,346; Fraser & Chalmers, \$15,905. Contract was awarded as follows: Building and sedimentation basin, Canadian Engineering & Construction Co.; filter equipment, Roberts Filter Mfg. Co.; pump equipment, Turbine Equipment Co.

Goderich, Ont.—Town Council is selling an issue of \$14,997.15 sewer debentures. Treasurer, L. L. Knox.

Niagara Falls, Ont.—By-laws were passed by City Council providing for raising of \$18,469.36 and \$11,833 to pay for the construction of extensions of water mains on certain streets. City Clerk, W. J. Seymour.

Ottawa, Ont.—Contract for supply of one water meter testing scale has been awarded by the City Council to the General Supply Co. of Canada, Ltd., Ottawa.

Ottawa, Ont.—Contracts for supply of water meters for city have been awarded as follows: To General Supply Co. of Canada, Ltd., Ottawa, 75— $\frac{5}{8}$ -in. Buffalo meters; Neptune Meter Co., Toronto, 25— $\frac{3}{4}$ -in. Trident meters. 30—2-in., 6—3-in., 4—4-in., 2—6-in.; National Meter Co., New York, 1—8-in. Empire compound meter.

Pentticon, B.C.—Municipal Council awarded contract for 4,300 ft. of 4-in. water pipe to T. B. Ross & Co., of Victoria, at \$2,745, plus tax. Council also approved of an order amounting to \$1,809.20 being placed with the Taylor-Forbes Co., of Vancouver, for various fittings for domestic water extensions.

St. Catharines, Ont.—Tenders will be received, addressed to the Chairman, Board of Works, City Hall, until 5 o'clock p.m., Thursday, May 25, for the construction of approximately 9,200 lin. ft. of 10-in. to 36-in. sewers. Plans and specifications on application to W. P. Near, City Engineer. (See official adv.)

Todmorden, Ont.—A resolution was adopted at meeting of Todmorden Ratepayers' Association, that York Township Council be requested to secure the best sewerage scheme the engineers can propose for this district, with the estimated cost, same to be submitted to a vote of the people at an early date.

Toronto, Ont.—City Council intends to construct water mains in Evans and Forman Avenues at a cost of \$4,605. Also sewers in Cortleigh Crescent and Rosewell Ave., at cost of \$6,500.

Toronto, Ont.—Works Commissioner R. C. Harris advised the Board of Control that he is having plans and estimates prepared for a comprehensive sewerage system for the whole of North Toronto, involving an expenditure of several millions of dollars.

Toronto, Ont.—City Council passed by-law providing for raising of \$315,000 to provide for the cost of certain improvements and extensions to the water works system, as follows: For repairs and reinforcements to the water supply intake, \$200,000, and for 12-in. main on Yonge St., from Chaplin Crescent to north city limits, \$102,000, aggregating the sum of \$302,000.

Toronto, Ont.—Tenders, addressed to C. Alfred Maquire (Mayor), Chairman, Board of Control, will be received until noon, Tuesday, May 23, for the construction of the following sewers: Western Harbor Development Drainage System—Section 1, 2,000 ft. east of Parkside Drive to 1,478 ft. farther east; Section 2, Parkside Drive to Windermere Ave.; Section 3, Windermere Ave. to Jane St. Specifications may be seen at the Works Department, Room 6, City Hall.

Vancouver, B.C.—Civic Board of Works authorized construction of sewers at cost of \$48,060. City Engineer, F. C. Fellowes.

Winnipeg, Man.—The sum of \$50,000 is at the disposal of the Public Utilities Commission for the installation of water and sewer services.

Winnipeg, Man.—Civic Utilities Committee authorized construction of sewer in Ingersoll St., at cost of \$6,517, and a water main in Dominion St., costing \$848. Committee instructed City Engineer W. P. Brereton to bring in estimate of cost of giving residents on Telfer St. sewer service.

LIGHT, HEAT AND POWER

Calgary, Alta.—City Commissioners have recommended the purchase of a Lincoln arc welding outfit at a price of \$4,092 f.o.b. Calgary, from the Electrical Engineers, Ltd., Calgary.

Calgary, Alta.—Lee Drumheller has announced that steps have been taken by the Drumheller Land Co., Ltd., to erect a new generator to replace the one lost at the Callie mine fire recently.

St. John, N.B.—Common Council adopted a resolution authorizing a bond issue of \$900,000 for the erection of a civic Hydro distribution system.

Toronto, Ont.—Civic Property Committee sent on a recommendation to Board of Control for improved street lighting on Queen St., from Teraulay St. to Sunnyside, at a cost of \$17,000.

Winnipeg, Man.—Tenders close May 15 for erection of a switch house building for the Hydro-Electric System in Cornish Park. City Clerk, C. J. Brown.

Winnipeg, Man.—Contract for construction of a conduit connecting the present duct at Maryland bridge to Scotland Ave., Fort Rouge, was awarded to the Carter-Halls-Aldinger Co., of this city, for \$25,000, by the Civic Utilities Commission.

RAILWAYS

Kingston, Ont.—Canadian Pacific Railway Co. plans to spend \$50,000 in building an overhead crossing over the Grand Trunk tracks immediately west of Kingston.

Medicine Hat.—Work has started on the construction of a 280-ton mechanical coaling plant for the C.P.R. Contractor, G. E. Hughes, of Calgary.

Saugeen Junction, Ont.—Township of Osprey wants a branch line of the C.P.R. extended from Saugeen Junction, on the Owen Sound branch of the road, to a point in Collingwood or Osprey Township.

FACTORIES AND LARGE BUILDINGS

Birch Cliff, Ont.—Tenders totalling \$132,000 for the erection of High School in Scarboro Township to the Carswell Construction Co.

Blairmore, Alta.—Contract awarded to E. J. Pozzi for erection of two-storey brick building.

Blairmore, Alta.—Mark Sartoris' wholesale house, damaged by fire, will be remodelled by C. Ericson.

Brantford, Ont.—Dominion Dress Goods Co. will erect a new three-storey factory building at South and Alfred streets.

Brantford, Ont.—It is stated that a local textile industry has plans for large extensions. City Clerk, H. F. Leonard.

Brantford, Ont.—The Terrace Hill public school will be built if the almost unanimous recommendation of the buildings and grounds committee of the Board of Education is accepted by the Board as a whole at its next meeting. Estimated cost, \$150,000.

Calgary, Alta.—Ford Motor Co. plans immediate start on construction of building on Eleventh Ave. at an approximate cost of \$150,000. Local Manager, H. R. Cottingham.

Calgary, Alta.—Superintendent of the Street Railway has been authorized by the City Council to purchase steel rails from the Moose Jaw Street Railway Co., at a price of \$25 per ton f.o.b. Moose Jaw. This makes a price with freight of approximately \$33.77 per ton f.o.b. Calgary for a total expenditure of \$5,403.20.

Chatham, Ont.—Plans for proposed Technical School were submitted to the Board of Education by John Methven. Plans call for a three-storey fireproof building of reinforced concrete with brick facing costing \$300,000.

Colborne, Ont.—A site has been selected for proposed new High School building.

Cornwall, Ont.—Contracts for addition and alterations to Cornwall Public School awarded as follows: General contract, Charles Holbrook & Sons, Ottawa, \$55,000; plumbing, heating and ventilating, McKinley & Norwood, Ottawa, \$19,300.

Daysland, Alta.—Work will start at once on erection of creamery building for E. C. D. Creameries. Supt., J. P. Donald, of Edmonton.

Durham, Ont.—Movement on foot for erection of new Town Hall. Clerk, Wm. E. Vollet.

East Zorra Tp., Ont.—Township Council passed by-law authorizing raising of funds for erection of school house in S.S. No. 6. Clerk, Edwin Parker, Tavistock, Ont.

Edmonton, Alta.—Finance Committee recommended to City Council purchase of a site for a children's home to cost about \$35,000. City Clerk, C. E. K. Cox.

Edmonton, Alta.—E. L. Hill, Secretary, Library Board, has received word that building of a new public library must proceed during the present construction season if advantage is to be taken of the \$112,500 grant from the Carnegie Corporation.

Edmonton, Alta.—Building of the Edmonton, Dunvegan and B. C. Railway line towards the British Columbia boundary will be continued this spring according to an announcement made by Charles Murphy, general manager of the Canadian Pacific Railway western lines. This railway is now being operated by C.P.R.

Fort William, Ont.—Stores and workshop sections of the Northern Engineering Co., comprising the newest wing of the plant owned by W. J. Ross were destroyed by fire, the loss being about \$25,000.

Fort William, Ont.—Bulk tenders were received by the City Council for track construction, but were rejected as being too high. Tenders are being called for separate jobs, such as track construction, ditching and overhead work.

Fort William, Ont.—C. P. R. Co. has awarded contract for the second new elevator here to the McDonald Engineering Co., of Chicago. Structure will be of steel and will be fireproof, with a capacity of 2,500,000 bushels. Estimated approximate cost, \$1,500,000. Work will start at once.

Fort William, Ont.—Over half a million dollars will be spent by the Canadian Pacific Railway Co. this summer upon improvements to their big coal docks on Island No. 1, at the mouth of the McKellar River. The improvement will consist of a huge storing or distributing crane and the general enlargement of the coal handling and storage facilities of the docks.

Galt, Ont.—Tenders, addressed to Newlands & Co., Ltd., will be received until noon, Tuesday, May 30, for the excavating for, and the erection of a new mill building. Tenders for separate trades and in bulk will be considered.

Hamilton, Ont.—Plans for proposed Bank of Hamilton branch at the Delta have been forwarded to the city building inspector. Cost, \$40,000. Delta Properties, Ltd., plan erection of building at the Delta at approximate cost of \$150,000.

Hamilton, Ont.—Bank of British North America building, 12 King St. east, has been purchased as headquarters of Hamilton Hydro-Electric system. Alterations and extensions costing \$65,000 will be made. Secretary of Commission, W. H. Childs.

Hespeler, Ont.—Municipal authorities have received a grant of \$12,250 from the Carnegie Trust Corporation towards the erection of a library building. Total cost, \$18,500. Clerk, M. E. Jardine.

Humberstone, Ont.—Separate and bulk tenders for all trades required for the erection of a 4-room public school will be received by L. R. Snider, Sec.-Treas., until noon,

Tuesday, May 23. Plans and specifications may be seen on application to the Secretary-Treasurer and Norman A. Kearns, Architect, Welland.

Kensington, P.E.I.—Fire destroyed the new mill of the Kensington Sash and Door Factory, owned by Messrs. Barnard. Loss, \$6,000.

Kirriemuir, Alta.—Tenders will be received by J. L. Jamieson, Superintendent, until May 20, for the construction of a standard section house. Further information may be obtained at the Canadian Pacific Railway station, Edmonton.

La Fleche, Sask.—Roman Catholic church building will be erected here at cost of \$20,000.

Lakefield, Que.—Canada Cement Co., Ltd., will commence work at once on the reconstruction of their plant here. Construction Engineer, J. A. Creaser.

Lewvan, Sask.—Tenders closed May 11 for erection of a school building for Centre View School District No. 4460. Sec.-Treas., L. H. Harker, Lewvan.

Lindsay, Ont.—Town Council passed by-law to construct or improve the highway on Colborne St., from Angelina St. to William St. Clerk, W. R. Allely.

London, Ont.—Civic Commission decided to recommend to City Council that new Municipal Building be erected on site of present City Hall.

London, Ont.—Ground has been broken for the new plant of the London Bridge Works, Ltd., which will be of modern steel fireproof construction throughout and equipped with the latest machinery for the production of steel structures of all kinds, chiefly bridges and buildings. An extensive warehouse will also be built and equipped for the distribution of iron and steel products. President, T. J. Dillon, Welland.

Melbourne, Ont.—Arrangements are being made to start work shortly on the new school building. Trustee, Dr. Dewar.

Melbourne, Ont.—Tenders will be received by W. J. Laing, Secretary, Melbourne, until 5 p.m., May 20, for the erection of a red brick Continuation School. Plans may be seen on application to the Secretary and also at office of W. G. Murray, Architect, London, Ont.

Mildmay, Ont.—Establishment of a continuation school here is under consideration. Clerk, John A. Johnston.

Moncton, N.B.—J. A. Roy plans erection of business block on corner of North and Union Streets. Estimated cost, \$10,000.

Moncton, N.B.—Contract for construction of service station for Simms, Ltd., has been awarded to the Parsons-Ed Co., of this city.

Montreal, Que.—Permit issued to the Protestant School Board to extend the present school building on Canning St. with a 92 by 62 ft. addition.

Mount Dennis, Ont.—Members of Mount Dennis Methodist church plan erection of new church building at cost of \$30,000. Pastor, Rev. D. R. Gray.

Nipigon, Ont.—Enlargement of Nipigon Fibre Pulp & Paper Company's plant is planned.

Ojibway, Ont.—Ward E. Perley, Vice-President of the Canadian Steel Corporation, announced that building activity on the company's \$20,000,000 plant now under construction, will be increased in the near future.

Oshawa, Ont.—R. S. and George W. McLaughlin, President and Vice-President, respectively, of the General Motors of Canada, announced that they will erect a maternity wing to the Oshawa Hospital, to be known as the McLaughlin Memorial Wing.

Ottawa, Ont.—Fire destroyed a portion of the Barrett Bros. sawmill and storage houses.

Ottawa, Ont.—Members of St. Luke's Church plan erection of new church building. Rector, Rev. J. E. Lindsay.

Ottawa, Ont.—School Board will call tenders for erection of administration building on corner of Gilmour and O'Connor Sts. and for an addition to Kent St. School.

Ottawa, Ont.—Contracts for masonry, brick and carpentry work for main building of new civic hospital awarded to A. I. Garvoek at \$220,884. A tender was also received from T. C. James, at \$298,854.

Ottawa, Ont.—New tenders are to be called for the masonry, brick and carpentry work for the main building of new Civic Hospital. This is necessitated by an error in price made in tendering by Alex. I. Garvock, to whom the contract was awarded.

Ottawa, Ont.—The Gilmour Construction Co. were awarded contracts for Cambridge St. and Glashan Schools in bulk, at \$27,297 and \$34,302.32, respectively. Other bulk tenders received were: T. C. James, \$30,460 and \$35,489 and The Bate-McMahon Co., \$32,793 and \$39,742.

Ponoka, Alta.—Plans are being prepared by R. P. Blakey, Provincial Architect, for a new unit of the buildings of the asylum for the insane here. Tenders will be called in about a month's time.

Portage la Prairie, Man.—Canadian National Railways plan the laying of heavy steel between Portage and Brandon and Brandon and Kipling this year.

Preston, Ont.—Hurlbut Shoe Co. will enlarge its plant.

Quebec, Que.—Tenders for construction of School of Tres St. Sacrement were received until May 13 by Antoine Taschereau, Sec.-Treas., Roman Catholic School Commission, Parliament Bldgs.

Riverside, Ont.—Enlargement of Edith Cavell school at cost of between \$30,000 and \$40,000 is proposed. Architect, G. B. Colthurst.

Regina, Sask.—Contract for construction of Roman Catholic chapel on Northside has been awarded to D. J. Murphy.

Regina, Sask.—Western Development Co., Ltd., will erect large building on Hamilton St., for which contract has been awarded to the Poole Construction Co.

St. Mary's, Ont.—Town Council granted \$19,000 for improvements to the Collegiate Institute.

St. Mary's, Ont.—Ratepayers passed by-law to guarantee \$20,000 bonds for new factory of the Hurlut Shoe Co.

St. Thomas, Ont.—Frank H. Alfred, president of the Pere Marquette Railway, announced here that a new depot costing \$30,000 is to be erected in Sarnia this year and a large section of the Canadian division roadway improved.

St. Thomas, Ont.—A by-law providing for the issuing of \$260,000 in debentures to cover the cost of erecting and equipping a vocational school is to be submitted to the ratepayers at an early date.

St. Williams, Ont.—Fire destroyed the furniture factory and planing mill of McCall & Co. together with dry kiln and two large lumber sheds.

Sarnia, Ont.—Ratepayers passed by-law granting fixed assessment to Dominion Alloy Steel Corporation, the \$5,000,000 company which is to erect a plant here.

Silverthorn, Ont.—Congregation of Silverthorn Methodist Church plan erection of new church building at cost of \$30,000. Pastor, Rev. W. J. Aldridge.

Sydney Mines, N.S.—Competitive plans for an 8-room fireproof school building will be received until May 20, by D. C. McDonald, cost to be not more than \$70,000.

Sydney Mines, N.S.—School Board plans erection of school at cost of \$75,000. Bank of Nova Scotia plans erection of office building, work to commence about June 1.

Toronto, Ont.—City Architect's department issued permit for an extension to a large bowling alley at cost of \$45,000.

Toronto, Ont.—City Council passed by-law providing for raising of \$25,000 for purchase of site for proposed Observation Home.

Toronto, Ont.—Standard Bank is ready to begin erection of a new building for their Bedford Park branch on Yonge St., opposite Bedford Ave.

Toronto, Ont.—City Council passed by-law providing for the raising of \$100,000 for the erection of a Nurses' Home for the Isolation Hospital.

Toronto, Ont.—By-laws passed by City Council providing for raising of \$91,000 for purchase of site for proposed new Police Administration building.

Toronto, Ont.—Members of Morningside Presbyterian Church plan erection of Sunday School building at cost of \$50,000. Pastor, Rev. J. Gordon Cheyne.

Toronto, Ont.—Campaign to raise \$40,000 for erection next fall of new church building has been launched by members of St. Clair Avenue Baptist Church.

Toronto, Ont.—Lakeview public school trustees decided to build a four-room addition to the school north-east of Stop 35, and a two-room unit for a school east of Stop 34.

Toronto, Ont.—Separate and bulk tenders will be received until May 20, at noon, by J. M. Cowan, Architect, 3 Carlton St., for all trades required in the erection of 4-room addition to St. Rita School, Edwin Ave., for the Trustees of the Toronto Separate School Board. Plans and specifications may be obtained at office of architect.

Toronto, Ont.—Separate School Board awarded following contracts in connection with erection of school in Moore Park: Carpenter work, Hickey Construction Co., \$11,500; masonry, F. Holmes & Son, \$21,490; heating, T. E. Regan, \$4,100; plumbing, V. E. Winpenny, \$3,500; structural J. J. Glynn, \$1,675; electric wiring, Moss & Hock, \$460; steel, MacGregor & McIntyre, \$1,549; plastering, Beaver & Co., \$1,450; painting, A. Richard, \$1,395; roofing, etc., marble work, J. G. Gibson Co., \$1,280.

Vancouver, B.C.—Permit issued for erection of warehouse for Shell Co. at cost of \$4,000.

Vancouver, B.C.—Permit issued for new school to be erected on Quebec St. by St. Patrick's parish. Cost, \$30,000.

Victoria, B.C.—Fire damaged Arcade Building to extent of \$250,000.

Victoria, B.C.—Contract for erection of business block on southeast corner of Douglas and Fisgard Sts. for Thos. R. Cusack and associates has been awarded to Luney Bros., Ltd. Cost \$20,000.

Victoria, B.C.—Members of Gizeh Temple (Shriners) of this city are agitating for the erection of a hospital for crippled children in this province. Executive of Royal Jubilee Hospital have offered a site for this purpose in this city.

Welland, Ont.—Permit issued to St. Thomas Packing Co. for erection of plant at corner of Hellesms Ave. and Division St.

Welland, Ont.—Tenders have been called by Empire Cotton Mill for construction of addition to factory. General Manager, J. D. Payne.

Welland, Ont.—The plant of Electric Steel & Metals, Ltd., it being taken over by a Pittsburgh syndicate and a large extension will be built to the plant.

Weston, Ont.—By-law providing for the raising of \$115,000 for addition to High School will be submitted to ratepayers. Clerk, J. H. Taylor.

Winnipeg, Man.—Work has started on construction of \$250,000 I.L.O.O.F. Home by Grand Lodge of Manitoba.

Winnipeg, Man.—Tenders will shortly be called for construction of \$500,000 film exchange building on Ellice Ave.

Winnipeg, Man.—Preliminary steps toward construction of an office building for the use of dentists and physicians have been taken here.

Winnipeg, Man.—Plans are being prepared for two new schools, a 14-room school at Mountain Ave. and Parr St., and a 14-room school on Grosvenor Ave.

Winnipeg, Man.—Permit issued for \$12,170 for an addition to Cecil Rhodes School, and another for \$18,000 for an addition to Lord Nelson School No. 2.

Winnipeg, Man.—Contract for construction of 14-room school on Schultz St., between Flora and Stella Sts., has been awarded to Hazelton & Walin, Ltd., of this city, for \$66,123, contract for installation of heating and ventilating system has been awarded to Bowyer Boag, Ltd., for \$13,865. Other tenders received were: General contract—Sutherland Construction Co., \$67,900; Fraser & McDonald, \$73,998; Carter-Halls-Aldinger Co., \$67,729; Smith Construction Co., \$79,284.13; H. Sigurdson, \$72,453; J. P. Tremblay Co., Ltd., \$69,975; J. McDiarmid Co., Ltd., \$70,800; Fort Garry Construction Co., \$68,942; Wallace and Atkins, Ltd., \$67,547; S. Brynjolfsson & Co., \$68,724; Claydon Co., Ltd., \$66,586. Heating and ventilating, Bowyer-Boag, Ltd., \$13,865; Cotter Bros., Ltd., \$13,937; Green

and Litster, Ltd., \$14,695; James Ballantyne Co., Ltd., \$14,987; Keller & Whitfield, \$14,990; John Plaxton Co., Ltd., \$15,560; Standard Plumbing & Heating Co., \$14,878; Chas. D. Kirk Co., \$11,700; Chas. Gate & Sons, \$15,300.

Woodville, Ont.—Tenders either in bulk or for separate trades required in the erection of Public and Continuation School, will be received until 8 o'clock p.m., Friday, May 19, by A. Good, Secretary, Woodville S.S., Woodville, Ont. Plans and specifications may be seen either at Woodville or at office of John T. Hornsby, Architect, 4 William St. North, Lindsay, Ont.

MISCELLANEOUS

Baker Brook, N.B.—Losses estimated at \$100,000 were caused by fire which destroyed the shingle mills of the Fraser Companies, Ltd., the C. N. R. section house, the Temiscousta Railway bridge, etc.

Brantford, Man.—Contract for city's annual supply of castings awarded to the Hartley Foundry Co., Brantford.

Calgary, Alta.—City Commissioners have recommended the purchase of a 1-ton International gasoline truck from the International Harvester Co., at \$1,975 f.o.b. Calgary.

Edmonton, Alta.—Contracts for about 1,000 miles of rural telephone line extensions awarded by Provincial Telephone Department as follows: A. McGregor, James Mohler, Albert Olsen, Berwick & Cowherd and J. Glover. Tenders were for labor only and totalled \$100,000. Tenders will be called for in June or July on next lot of work to be taken up this season. Contract for one-storey branch office for the telephone department at Hillhurst, Calgary, was awarded to Gouley & Vanderhogan, of Calgary.

Kapuskasing, Ont.—If the plans of J. A. Ellis, Director of the Provincial Bureau of Municipal Affairs, are approved, Kapuskasing in New Ontario, will be laid out on a model town-planning design.

Lachine, Que.—Following contracts for supply of materials awarded: Stone, sand, cement and clay pipe to Le Pallleur Freres, Ltd.; Lachine; bitumen, Barrett Co., Ltd., Montreal; paving, Leger & Charlton, Ltd., Lachine.

Lethbridge, Alta.—Considerable progress has been made thus far in the negotiations between the Government, the C. P. R., the Southern Irrigation District and the farmers concerned in the expansion of the Canadian Pacific Irrigation system in the south and east areas, a scheme which may ultimately bring under water right double the present C. P. R. block acreage, or approximately 160,000 acres. The construction of a new dam and headworks at Kimball, estimated to cost over \$200,000, will be proceeded with providing the negotiations now in progress are successful.

Mimico, Ont.—Town Council sold an issue of debentures amounting to \$98,000 for the following purposes: School purposes, \$65,000; sewage disposal plant, \$13,000; and Hydro, \$20,000.

Oakville, Ont.—Oakville Ratepayers' Association passed a resolution asking the Town Council to appoint a town-planning commission, or committee of Council, to take charge of the lay-out of sub-divisions, laying of streets and sidewalks, and to have general supervision over all building and general layout of town improvements, both inside the town and for a radius of three miles beyond the limits of the corporation.

Ontario, Province of.—Provincial charters granted to following companies: Lower Sturgeon Power Co., Limited, Toronto, capitalization, \$600,000, director, John H. Black; Night Hawk Peninsular Mines, Ltd., Toronto, capitalization \$5,000,000, Geo. A. Grover, director.

Ottawa, Ont.—Following are names of companies incorporated under Dominion charter, with head office, authorized capital and name of one director: Jefferson Mines, Ltd., Jefferson Mines, \$2,500, Geo. E. Buchanan; Fibre Asphalt Products, Ltd., Toronto, \$600,000, W. H. Price;

Inter-Provincial Plastering Co., Ltd., Windsor, \$10,000, Stanley R. Ratcliffe; Radio Heating System, Ltd., Montreal, \$250,000, Jos. Vigneault.

Ottawa, Ont.—At a recent meeting of the Town Planning Commission, which was attended by a large number of property owners and representatives of public bodies, Chairman Noulan Cauchon explained the plans of the Sherwood Drive, for the widening of Fairmont Ave., the extension of Reid Ave. to Armstrong St., the extension of Ruskin St. to Fairmont Ave. and the improvement of street railway accommodation to the new civic hospital.

Quebec, Province of.—Following companies have been incorporated under Provincial charter: Association of the Electrical Contractor Dealers of the Province of Quebec, Inc., Montreal, capitalization, \$50,000, Nazaire Simoneau, director; Wireless & Electric Co., Ltd., \$20,000, Anatole Rioux.

Revelstoke, B.C.—The auto road up Mount Revelstoke is to be pushed to completion this season, according to an announcement received from L. W. Humphrey, M.P., who states that he has the assurance of the Dominion Works Department that operations will be resumed on the road shortly. An appropriation has also been authorized for the prosecution of a survey of the Columbia River at Revelstoke.

Sarnia, Ont.—Ratepayers passed a by-law authorizing expenditure of \$28,000 on fire-fighting equipment. City Clerk, M. D. Stewart.

Saskatchewan, Province of.—Tenders for construction of a drain will be received by H. S. Carpenter, Deputy Minister of Highways, Regina, until 12 o'clock noon, Saturday, May 20. Several culverts and bridges will be constructed and approximately 9,000 yds. of earth removed.

Vancouver, B.C.—Provincial charter granted to Perry Contracting Co., Ltd. Capitalization, \$10,000.

Victoria, B.C.—Provincial charter granted to M. C. Mining Co., Ltd. Capitalization, \$500,000.

West Luther Tn., Ont.—Tenders will be received by W. W. Duncan, Clerk, Conn P.O., Ont., until 4 o'clock, May 27, for the construction of a municipal drain, containing about 20,300 cu. yds. of excavation. Plans and specifications may be seen at the clerk's office.

Tenders Called For

CITY OF ST. CATHARINES, ONT.

TENDERS FOR SEWERS, PAVEMENTS, SIDEWALKS.

SEALED TENDERS will be received addressed to the Chairman of the Board of Works, City Hall, St. Catharines up to 5 o'clock p.m. of Thursday, May 25, 1922, for the construction of approximately:—

9,200 Lineal Feet of Sewers from 10 in. to 36 in. in diameter.

10,000 Square yards of Concrete Foundation for Pavements, including curbs and gutters.

6,000 Square yards of Cement Concrete Pavement.

9,600 Lineal Feet of Concrete Sidewalks.

Plans, profiles and specifications may be seen at and forms of tender obtained from the office of the City Engineer. Envelopes containing tenders must be plainly marked as to contents. All tenders must be accompanied by a marked cheque for five percent. of the amount of the tender together with the name of an approved guarantee company.

The lowest or any tender is not necessarily accepted.

W. P. NEAR,

City Engineer.—326

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

High Level Concrete Bridge, Elora, Ont.

Two Span Reinforced Concrete Arch Structure 85 ft. High Replaces Steel Truss Structure — Old Trusses Utilized as Support for Ribs During Concreting — Deck Supported by Ribs — Old Masonry Utilized

By A. W. CONNOR

Consulting Engineer, Toronto.

CERTAIN unusual constructional features were adopted in the new high level reinforced concrete arch bridge completed last autumn over the Irvine River near Elora, Ont. This stream flows into the Grand River at Elora through a deep, rocky gorge about 120 ft. wide by 80 ft. in depth. The Grand River falls into the same gorge not far above the confluence.



FIG. 1—COMPLETED BRIDGE AT ELORA, SHOWING OLD MASONRY PIER

There is a 4-span steel bridge over the Grand River just above the falls, and the new concrete bridge was constructed by the County of Wellington over the Irvine River at a point a few hundred yards from the confluence with the Grand. The first bridge was built here about 1853. Long timbers were run out from either side and lashed together by two sailors brought up from the Atlantic coast. These were then trussed up and the wooden bridge completed. In 1887 a masonry pier was built in the gorge and the old bridge was replaced by a steel deck bridge of two 60-ft. spans. This bridge has been in service ever since and was used to advantage in the erecting of the new concrete arch bridge.

The old pier was in excellent condition, having been constructed by English masons and the stones bonded together with iron anchors. It was 10 by 24 ft. at the base, tapering to 4 ft. 3 in. by 18 ft. at about the spring of the new arch. At this elevation there was a 6-in. offset and the upper part was carried up plumb. The pier was used without alteration below this bridge. Above this ledge, recesses were cut on the sides to receive the new arch ribs. After the ribs had set and some weight could be taken off the shores of the bridge, the pier was cut down to make room for the concrete columns and above the extrados narrowed, for appearance to the width of the columns.

New Superstructure

The new bridge, shown in Figs. 1 and 2, consists of two open-spandrel arch spans of 61 ft. with a 19-ft. road-



FIG. 2—CONSTRUCTION OF DECK FORMS, SUPPORTED BY ARCH RIBS

way and a 5-ft. sidewalk on one side. The clear distance face to face of abutments is 123 ft. and the height of the floor above the water is 85 ft. The bridge is designed for a uniformly distributed live load of 135 lb. per sq. ft. or

for a concentrated load of 20 tons, being class "C" loading of the specifications of the Ontario Department of Highways.

There are two parabolic arch ribs with a rise of 12.2 ft. 24 in. thick and 30 in. deep at the crown. The ribs are 12 ft. 4 in. apart in the clear, being just wide enough to permit the forms to clear the old steel trusses. The overhang of the brackets is 5 ft. 10 in. on the sidewalk side and 3 ft. 10 in. on the other. The arches contain 7 panels of 3 ft. 10 in. with semicircular spandrel slab arches. The deck consists of a 10½-in. concrete slab on the roadway and a 4-in. slab for the sidewalk, carried by floor beams at the panel points. The railing is 4 ft. high on the sidewalk side and 4 ft. 6 in. on the roadway side, the sidewalk being 6 in. higher than the road. The open panels and top rail of the balustrade were precast, the former in two sections.

Erection Without Falsework

On account of the height of the structure, it was designed for erection without falsework, using the old steel trusses to support the new arch ribs. It was found that the old bridge was just strong enough to carry the ribs without the deck. To provide extra security, the forms for the ribs were built to act as an arch, with a horizontal tie consisting of old lateral rods used when the rib was being poured. The old bridge was a 5-panel, pin-connected deck, 60-ft. span with 12-in. I's 16 ft. long over the trusses which were 11 ft. centre to centre. It was arranged to allow the two centre I-beams to pass under the arch ribs. By putting 2-in. fillers under the other beams, they just passed over the ribs. The weight was carried to them by heavy iron stirrups. Each rib was poured uniformly from each end and a key section poured the following day. As the load on the truss was eccentric, the platform over the unloaded truss was counter weighted with stone. As each rib was being poured, a point on the formwork was sighted from a transit and constantly watched against tipping or undue settlement. The latter was about as expected, namely ⅝ in.

By the time the formwork for the deck was completed, the ribs had set sufficiently to carry the weight of the deck. This weight was distributed between the old trusses and the arch ribs. To secure equal settlement, the two systems were tied together.

The two central floor beams pass through the ribs. The steel was inserted and recesses 3 in. deep were left for the bearing of the beams. Expansion is provided in the deck at the ends and over the centre pier, the floor beam at this point being deeper and wider than the others.

The sidewalk slab was cast after the roadway and sidewalk brackets were completed. Curbs were cast with a slot for the precast panels, the rods for the posts being left projecting. The upper precast rail was cast with a groove to fit over the panel. Post forms were clamped around the panels and rails and poured to bind all together.

Conduits for electric wiring were cast into the curbs. The standards for the lights are also of precast concrete.

The total length of the structure with wing walls is 181 ft. 9 in. There are 311 cu. yd. of concrete and 15 tons of steel in the work. The cost of the bridge was \$15,200. Tenders were also called for a steel superstructure but the cost would not have been much less, so the Council decided to build a structure more in keeping with the surroundings. The contractors for the work were Reid & Somers, Ltd., of Toronto. The bridge was built by the County of Wellington, the writer acting as the engineer.

The Moncton Branch of the Engineering Institute of Canada held their annual meeting on May 16, when the following officers were elected: Chairman, F. B. Tapley; Vice-Chairman, F. H. Fripp; Sec.-Treas., M. J. Murphy; Executive, G. C. Torrens, J. G. Dryden, A. S. Gunn, C. S. G. Rogers, Prof. McKel, Kenneth Gordon.

HEAVY TRUCKS DAMAGE ROAD SURFACE

AT the annual meeting of the Ontario Motor Truck Owners Association, held in the King Edward Hotel, Toronto, on May 11, Hon. W. A. McLean, Deputy Minister of Highways for the Province, declared that it would cost the Government five hundred millions of dollars to put the Provincial Highways system into such shape that it would efficiently stand up under the wear and tear of loads carried by ten and twelve-ton motor trucks. Pointing out that expenditure on such an enormous scale was unthinkable, the Deputy Minister further stated that the only other alternative was the restriction of loads to be carried by trucks.

Although not suggesting any definite limit, Mr. McLean asked the truck owners to be reasonable in loading their vehicles, as the question was one which eventually would vitally affect their standing with the public. Mr. McLean outlined the development of motor bus and motor express traffic and ventured the prophecy that a very few years would see a phenomenal increase in these two types of traffic over Ontario roads.

S. L. Squire, of the Canadian Good Roads Association, also offered friendly warning to the truck owners in the matter of heavy loads. If you disregard common sense and reason, you will arouse public opinion to a point where it will declare that trucks will have to be kept off the roads. The service which the truck can render is an important one, but we do not go on loading trucks for some selfish reason to the point where they will break down the road foundation.

WEATHERPROOFING HUDSON RIVER BRIDGE

PROTECTION of the proposed bridge over the Hudson River from the weather by means of bronze has been recommended by the Engineers of that structure. The plan to weatherproof the bridge with bronze is described in the bulletin of the Copper and Brass Association, New York City.

A new and highly important feature introduced for the first time in a bridge of this great magnitude is that practically the whole of the Hudson River Bridge will be weatherproofed. That is to say, its steel work will be so completely enclosed with rain-and-moisture-excluding bronze, that the annual cost of repainting—a most serious item in the upkeep of big bridge—will be reduced to a minimum.

That this little matter of protection figures in maintenance economy and is indeed vital, is realized when it is understood that it is expected to reduce the cost of painting, which, if the entire surface of the steel structure were exposed, might easily amount to \$500,000 annually, and as only about 15 per cent of the structure will be exposed to the weather, the upkeep will be reduced accordingly.

In the Hudson River Bridge there are a pair of suspension trusses or inverted arches spaced 160 ft. apart, center to center, each truss consisting of 2 cables from 60 to 80 ft. apart vertically, with vertical panels and diagonal bracing between to supply the stiffening under passing loads. From the two suspension trusses vertical eyebars are suspended, and carry the double-deck floorway.

On the proper strength, functioning, and permanence of the chains depends the integrity of the bridge. Each eyebar is separated several inches from the adjacent bar, so that it can be inspected at any and all times. Each cable is enclosed in a covering or gallery of bronze for protection and to permit of inspection, so that once the eyebars are painted they will be well protected from the elements.

The chord thus assembled is 11 ft. in thickness, as compared with 15 in. for the wire cable of the Brooklyn Bridge, and with the enclosing covering is 15 ft. in external diameter. The estimated cost of the bridge proper has been placed at \$100,000,000. By the use of the bronze as a protection against the weather, a yearly saving in upkeep of more than \$400,000 is expected.

TREATMENT OF HARD, IMPURE WATER WITH ALUMINIUM SULPHATE*

Action of Alum in Water — Amount of Alum Can Only be Determined by Experiment — Principles Underlying Coagulation — Hydrogen ion Concentration.

By William Gore,
Consulting Engineer, Toronto.

THE art of treating water with aluminium sulphate ("alum," for short) for purposes of coagulating the impurities of color, turbidity or micro-organisms, in order to condition it previous to filtration or to settlement with or without filtration, is essentially experimental. In spite of the many researches that have been carried out into the problem, no one can at present determine the necessary amount of alum or the time required for the reactions to take place or the amount of residual alum in the filtrate in any given instance from a mere study of the salient characteristics of the water. This situation arises from the multiplicity of the important factors involved, and their interactions are such that in practice the problem becomes too unwieldy.

Notwithstanding this, great strides have been made in the study of the problem by various methods including that of abstraction, and a number of mile posts have been fixed along the road towards the complete solution of the problem.

In the treatment of drinking water with alum, the alkaline bicarbonates of calcium and magnesium existing naturally in the water are relied upon to decompose the alum in solution and to form insoluble aluminium hydrate, which is the active agent of coagulation; and as these bicarbonates are almost always present in abundance in hard waters, there will always be sufficient present to satisfy the chemical requirements of this reaction. This was practically all the text on the subject at one time considered to be necessary. But a little practical experience shows this to be by no means the case.

General experience has shown, and it has been confirmed in systematic experiments by Morison¹, Pirnie² and others, that increased quantities of bicarbonates in a water demand increased quantities of alum to treat it, and, as might be expected, the same applies to increased contamination and turbidities, but the law of increase is different in the two cases. In the former the action is often, although not always, such as would be expected if a certain amount of the alum floc went into solution or in some way failed to precipitate, and in the latter case the results are so very uncertain because of the uncertainty of the nature of the contamination. As an instance of the difficulty of estimating the effect of a contamination, it has been found in laboratory experiments that one part in a hundred million of gelatine dissolved in Lake Ontario water made coagulation exceedingly difficult.

Some interesting laboratory experiments on the effect on visual precipitation of clay and silica turbidities of various mineral salts when treated with alum have been made by Smith³. This visual effect, although somewhat different from the complete process involving filtration, does show that each substance has an effect of its own, and demonstrates how difficult must be the problem of predetermining the alum treatment for a natural hard water which contains many mineral matters. It is inter-

¹Morison, Capt. J. The Dose of Alum for Clarification of Water by Precipitation. Indian Journal Medical Research, Vol. III., No. 4, April, 1916.

²Pirnie, M. Application of Colloidal Chemistry to Study of Filter Effluents. Journal Amer. Water Works Association, Vol. IX., No. 2.

³Smith, Otto M. The Removal of Clay and Silica from Water. Journal Amer. Water Works Assn., Vol. VII., page 302.

*Paper read before Canadian Section of American Water Works Association at Brantford, Ont., May 13, 1922.

esting to note that soda ash, which has been used as a corrective for acidity in the alum treatment of very soft waters, showed a distinctly inhibitive effect on the clarification of the water by alum. The same applies to the bicarbonate of soda and most sodium compounds; in fact nearly all substances experimented with had an undesirable influence on final clarification.

Closer studies of precipitation in the light of colloid chemistry have shown that the process goes through various phases as the application of the alum is increased, and the experiments of Morison¹ previously referred to are exceptionally interesting in this particular. They show clearly there is an optimum amount of alum which increases with the alkalinity of the water; and, in addition, that coincident with the optimum amount of alum, no residual alum was found in the supernatant liquid but was found there at every other concentration. In these experiments the optimum amount of alum runs rather less than half the equivalent alkalinity, and it would be interesting to know if this relation is always the same.

The question of the existence of alum in filter effluents has been closely studied by Howard^{4,5} and Hannon and Wolman⁶, who have found that effluents from all treated waters examined gave residual alum reactions. In the case of Lake Ontario water at Toronto, it was demonstrated that the residual alum after filtration was a hydrate in colloidal form which subsequently became an aluminate the exact nature of which has not been determined.

Stein's⁷ experiments on the removal of tannic acid color by alum cover a wide range of both acid and alkaline waters and shows with the latter waters that aluminium hydroxide, although actually formed, is inhibited from precipitating by the tannic acid until an equivalent amount of aluminium hydroxide has formed, and this part of the subject has been worked out with considerable detail and should prove invaluable to filter operators.

Very few of the reactions that follow from the laws of ordinary chemistry take place in their entirety, or some of the expected precipitates do not show up in whole or in part. This is particularly noticeable in the weak solutions of chemicals used in the treatment of drinking water, and colloid chemistry treats of this branch of the subject. In the purest of pure water, about one in every six hundred thousand of the water molecules appears to be broken up into two fragments, one hydrogen nucleus constituting one fragment, and one hydrogen atom, one oxygen atom and one electron constituting the other fragment. These fragments of the molecules remain in the water in a peculiarly active state, in which they are said to be electrically charged, the exact meaning of which, however, is not completely understood. In this state the separate parts into which the molecules are broken up are called "ions". The hydrogen nucleus ion is described as positive and the remainder of the molecule negative.

The electrical explanation given is that a positive ion contains one electron less than is necessary for stability, and a negative ion one more electron than is necessary for stability. Thus the one contains an excess of that energy

⁴Howard, Norman J. Description, Operation and Purification Effected by Drifting Sand System in Toronto during 1918. Journal New England Water Works Assoc., Vol. 32, No. 4.

⁵Howard, Norman J. and Hannon, F. Alumina Hydrate in Mechanically Filtered Water. "The Canadian Engineer," May 13, 1920.

⁶Howard, Norman J. Statistical Record of Toronto Water, 1912-22. "The Canadian Engineer," May 9, 1922, page 469.

⁷Wolman, A., and Hannon, S. Residual Aluminium Compounds in Water Filter Effluents. Chemical and Metallurgical Engineering, Vol. 24, No. 17, April 27, 1921.

⁸Stein, Milton F. Some Notes on the Colloidal Chemistry and Water Purification. American Water Works Association, Vol. VII., 1921, page 571.

which the other lacks, and to the same extent. If a simple acid be added to this pure water, the amount of the dissociation increases, and, if, on the other hand, an alkali be added, the dissociation decreases.

This is the simplest possible abstraction of the principle underlying coagulation. The impurities in the water such as can be removed by coagulation and filtration appear to be ionized. The same applies to some extent to any and every substance dissolved or in suspension in the water. The removable impurities may be, and generally are, considerably larger than the molecular size, and consist of groups of molecules which in an ionized condition will remain suspended in water indefinitely by reason of their mutual repulsions, and, to some extent, by that form of energy known as Brownian movements, unless some change is made by which the ionization can be neutralized or balanced in some way by the addition of the proper ingredients in which the ionization is of an opposite character. In hard waters the ionization of the impurities is negative to that of aluminium hydrate precipitated from solution as described above, and thus coagulation takes place as the neutralization proceeds.

The act of catching the impurities by the alum is the fundamental point of coagulation and must not be confounded with the precipitation which follows it, and one must guard against the assumption that the water which visibly flocs the best will produce the best results when filtered. Sometimes this is certainly not the case. Unless the impurity is caught before filtration, very little prospect remains of it being caught at all. In laboratory experiments the mixing of the solution of alum with the water can always be carried out quickly, but not so in practice, where it is quite possible to find the reactions progress far too quickly for the best results. In some very few instances, however, it has been reported that hours, or even days, may elapse before the reactions are complete. Of these the writer has had no experience, but in any event in such cases it would probably be desirable to condition the water before treatment with the alum.

The nature of coagulation being closely associated with the hydrogen ion concentration in water, it has recently been suggested that a measure of it in water might be used to determine the necessary amount of alum to be employed and otherwise control the whole purification process, and some considerable progress has been made in which Hannon² at the Toronto Filtration Plant, in collaboration with Wolman, has done most important work. Hannon has shown that the precipitation effects do vary with the hydrogen ion concentration, but that with Lake Ontario water the alkalinity is too high to reach the optimum, or isoelectric point as it is called, with a reasonable amount of alum treatment alone, but this point has been approached by the application of mineral acids to the water. This, of course, might not be permissible in practice, but the application of carbonic acid, if it can be dissolved in the water, would be more effective and practical. This, however, could easily be applied in the much-maligned pressure filters with ease by maintaining an atmosphere of the gas in the filter.

The same end can be obtained by reducing the alkalinity of the water by softening, and a third method is to drive hydrogen ions into the water by electrolysis. There is in this method of controlling the purification of the water the possibility that the most effective hydrogen ion concentration floats about with the nature of the water.

It is, however, possible that a careful study of a particular water by this method may lead to some correlation regarding it and the alum requirements. In any natural water the variation in the hydrogen ion concentration is almost invariably due more to changes in the carbonic acid content than to anything else, as may be noticed by the considerable change in it due to filtration or to the treatment with alum, which, while reducing the alkalinity, increases the carbonic acid.

In the case of Lake Ontario water at Toronto, Howard has found that the most certain index of the amount of

contamination in the water and the corresponding alum requirement is the amount of free ammonia present, but no definite scale of relationship has been established, and seasonal changes appear to have a very considerable effect; but this seasonal effect is probably due to changes in the carbonic acid content.

Coagulation with this particular water appears to proceed much more favorably and satisfactorily during the winter months than the summer months, but this cannot be attributed entirely to temperature because the analysis of the results separated into those above and below a temperature of 45 deg. F. do not show the same difference that the corresponding comparison between the summer and winter results do show, but the hydrogen ion concentration is less in summer than in winter; i.e., the water is further removed from the isoelectric point. Hannon thinks that to be due to increased temperatures but absorption of carbonic acid by microorganisms may have the more important effect, as they are certainly more numerous in summer.

Smith has shown that the treatment of a hard water with alum is greatly simplified by softening the water with lime applied slightly in excess of the amount necessary to produce the minimum hardness, and quotes the case of Little Rock, Arkansas, as a satisfactory example. It also corresponds with experiments known to the writer on the reduction of color in the Otonabee River water. It also corresponds with the laboratory experiments of Morison¹ and Pirnie³ and the hydrogen ion concentration.

Summary of Conclusions.

1. A hard water invariably contains an excess of the necessary ingredients for decomposing the alum, but a trace of some form of aluminium remains in the water after filtration in the form of an aluminate except at one critical concentration, often too far removed to be realized in practice.
2. Every substance in the water, whether dissolved or suspended, has an effect upon the amount of alum required, and generally the higher the amounts of mineral matter and the harder the water the greater will be the need of alum to coagulate the impurities.
3. The necessary amount of alum or the proper treatment before adding the alum can be determined only by experiment.
4. Gelatinous compounds in hard water seriously inhibit coagulation.
5. The time required for the reactions to take place is mostly short, approaching the instantaneous and in some cases too short for the best results unless specially rapid means of mixing are adopted. In a few rare cases the reactions extend over a period of hours or days. In such cases special treatment becomes desirable.
6. In Lake Ontario water in the absence of considerable turbidity the free ammonia content is the best index of the contamination and corresponding alum requirements.
7. The study of the hydrogen ion concentration has been suggested as an index of the amount of alum required, and some forward steps have been made by this means.
8. If the hydrogen ion concentration of a water is a measure of the condition of that water for treatment with alum, then we might expect the presence or absence of free CO₂ to have a most important effect upon the problem.
9. Filtering in pressure filters in an atmosphere of CO₂ might be expected to bring the hydrogen ion concentration up to the isoelectric point with care and certainty, but the probability of corrosive effects would be increased.
10. Softening the water with lime has much the same effect.
11. Forcing charged hydrogen ions into the water would temporarily (at least) also have the same effect.
12. When the isoelectric point is reached, there is little or no residual alum in the filtrate, and the application of the alum is efficient.
13. Filtering water always raises the hydrogen ion concentration by forcibly separating the parts of the water

molecules in compliance with the better known principles of contact electricity, but the hydrogen ion concentration slowly returns to nearly its former value if the water is allowed to remain in contact with the air.

HUDSON RIVER VEHICULAR TUNNEL

DEFINITE progress is being made in the construction of the vehicular tunnel under the Hudson River, from New York City to New Jersey. The contract was signed on March 30 and ground broken for the powerhouse on the New York side, on the following day. The tunnel is being built by a commission composed of representatives of the States of New York and New Jersey, and the contractors are Booth & Flynn Ltd.

The tunnel, which will be of twin tubes, will be approximately 1½ miles between the land shafts. It will require 10,000 tons of structural steel, 700 tons reinforcing rods, 106,000 tons cast iron tunnel lining, 10,000 tons cast steel tunnel lining, 5,000 tons bolts and rods, 172,000 barrels Portland cement, 56,000 barrels natural cement, 44,000 cubic yards sand, 80,000 cubic yards gravel and 16,000 square yards waterproofing. The total excavation is 404,000 cubic yards.

The tunnel will cost \$19,331,723.50, the States of New York and New Jersey bearing the expense of the project. Because the tunnel will be used largely by motor vehicles, the greatest care and study has been necessary to provide proper and adequate ventilation to counteract the poisonous gases from the cars. Many tests have been made in other tunnels and precautions will be taken to obviate any trouble in this respect.

The contract contains some interesting features in regard to payments. The contractor is required to give a bond of \$4,000,000 for faithful performance of the work. In addition, 10 per cent. of the partial estimate is retained until \$1,000,000 is reached, after which payments are made in full. Vouchers of payment are made up, 45 per cent. by each State, each Commission retaining 5 per cent. until the total retained amount is accumulated. When the tunnel lining has been completed and compressed air removed, one half of this retained amount, or \$500,000, will be paid the contractor, the other half being retained until the completion of the work. The contractor may withdraw this retained percentage by substituting securities which are lawful investments for savings banks in each State, and will receive interest in such securities as it accrues. Any work not provided for in the contract may be done at cost plus 15 per cent., the cost to include labor and compensation insurance, but not the use of plant, tools, or any portion of overhead expenses.

Another interesting feature is the provision for financing plant expense. The contractor will be paid \$1,200,000 for the compressors and shields, payments to be made as the plant is erected; after the final payment for plant has been made a deduction of 8 per cent. from succeeding partial payments will be made until the sum advanced for plant has been reached, this in addition to the regular 10 per cent. retention. In the event that this amount has not been reached by the time the tunnel lining is completed, the remaining balance at that time will be deducted from the following estimate. This provision certainly relieves the contractor from a big item of initial expense and saves a large sum in interest charges which would otherwise be included in the bid as a portion of the overhead.

Payment is made for material delivered at the rate of \$75 per ton of steel, \$60 for cast steel and \$35 for cast iron. Progress payments are made monthly, and interest at the rate of 6 per cent. will be paid if they are delayed more than 30 days, or the final payment more than 40 days after the certificate of completion has been filed. The contract contains a strike clause which allows an extension of time to the contractor if the work is delayed by a strike not instigated by him.

TOWN PLANNERS ELECT OFFICERS

SEVERAL excellent speeches and notably a very fine presidential address marked the annual dinner of the Town Planning Institute of Canada, at the Chateau Laurier, Ottawa, on May 12.

Some aspects of the financial side of town-planning were touched by Dr. Adam Shortt, who also outlined a method of taxation by which cities would derive benefit from land booms. The process whereby shack towns and slum areas sprang up just outside of the city limits would go on eternally if cities did not make provision for taking in sufficiently large areas while the land was still farm land. Contrary to general opinion, this did not involve the expenditure of large sums of money and land used for farming was assessed as such. James Ewing, of Montreal, in a short address said that he believed that Montreal would soon have a town-planning commission.

The most important matter before the convention, which was the third annual meeting of the Institute, was the revision of the existing constitution and bylaws, many changes being made, which will be shortly submitted to the entire membership for approval. If approved, the new constitution will form the basis upon which the Town Planning Institute of Canada intends to seek incorporation as a Dominion body.

An invitation was extended by H. L. Seymour, of Toronto, for the holding of the next convention in that city, and it was forwarded to the new executive for consideration.

There were a number of important papers read during the convention having to do with town planning, and suggested physical and social improvements applicable to this Dominion, not the least in interest being that read by Thomas Adams, past president of the institute on "Zoning." In addition, he gave the details of a comprehensive town planning scheme which is now being applied to the city of Welland, illustrating all its features with the aid of blueprints and maps.

In his address on Zoning, he described its many advantages which are applicable to all phases of municipal life; where the industrial areas are designated and with the manufacturing sites segregated from the residential and park sections, while the zones also apply to the character of buildings allowed in them and mean a reduced fire hazard.

Papers were to have been read by W. E. Hobbs, director of town planning, Manitoba, and T. D. Le May, city surveyor of Toronto, but time did not permit, and it was decided to write the addresses into the proceedings and have them published in the Journal of the Institute.

J. P. Hynes, Toronto, was elected president; James Ewing, Montreal, Noulain Cauchon, Ottawa, and W. A. Begg, Regina, vice-presidents; Major Douglas H. Nelles, Ottawa, honorary secretary-treasurer, and W. D. Cromarty, Ottawa, librarian. The council elected were: Messrs. H. L. Seymour, Toronto; H. B. Dunington-Grubb, Toronto; Prof. Percy E. Nobbs, Montreal; F. G. Todd, Montreal; Lieut.-Col. E. T. B. Gilmore, Ottawa; A. A. Dion, Ottawa; Prof. A. A. Stoughton, Winnipeg; L. O. Charlesworth, Edmonton; Prof. E. E. Buck, Vancouver, and W. F. Burditt, St. John, N.B.

McGILL ENGINEERING GRADUATION

RESULTS of graduation in the engineering faculties of McGill University, include the following: Honors in Applied Science, P. E. Biggar, Ottawa; Honors in Mechanical Engineering, E. C. Duff, Carbonear, Nfld.; B.A.Sc., degree R. O. Bales, civil engineer, Belle Isle Station, N.B.; I. W. Clarke, chemical engineering, Bear River, N.S.; R. H. Foss, mechanical engineering, Sherbrooke; W. R. McClelland, metallurgical engineering, Halifax; R. A. McGregor, mechanical engineering, New Glasgow; D. W. MacKean, civil engineering, Halifax; J. E. Taylor, chemical engineering, St. John West.

PREVENTION OF SEWAGE CONTAMINATION IN ONTARIO*

What the Provincial Board of Health is Doing to Protect the Water Works Operated by the Various Municipalities — Four Divisions of Board's Activities.

By F. A. Dallyn

Sanitary Engineer, Ontario Board of Health

SPEAKING generally, there seems to be some misapprehension as to the function of the Ontario Board of Health with reference to what the Board is doing to protect the various water works throughout the province from sewage contamination. It has been wrongly assumed by many that it is the duty of the Provincial Board to undertake the correction of conditions for which the redress lies within the power of the local authorities. It is true that there are certain general clauses in the Public Health Act which empower the Provincial Board to supervise such matters; at the same time there are, also, other clauses prohibiting the pollution of streams, the enforcement of which lies within the power of any individual or any municipality caring to prosecute the matter. So, in the legislation opportunity is afforded for individuals other than the Board to take action.

When one stops to realize the size of Ontario, the scattered nature of the urban developments and the small Government appropriations which are available in any one Department, it is not to be wondered that the Provincial Board is loath to assume the task of minding the business of the municipalities.

The task of the Board must necessarily be that of supervision. The exercise of this function has brought some splendid results during the past ten years. In 1910 the typhoid death rate in cities was 51.5 per 100,000, and in 1919 it had been reduced to 4.3. In 1920 it was 5.5. This reduction has been gradual, as in shown in Table 1.

TABLE 1—TYPHOID RATE PER 100,000 POPULATION.

	1920	1919	1918	1917	1916	1915	1914	1913	1912	1911	1910	1909	1908
Counties	6.2	4.61	5.10	6.6	8.1	9.4	10.0	13.3	10.9	16.1	22.0	25.1	20.5
Cities	5.5	4.3	9.6	7.5	12.1	9.4	12.4	17.3	27.7	35.8	51.5	34.3	37.8
Towns	25.0	19.5	17.2	31.4	52.2	38.0	47.4	46.0	47.0	62.3	56.4	67.7	107.1
Averages for Province	7.0	5.2	7.51	8.4	12.5	10.7	13.5	16.7	18.7	25.3	31.5	29.9	29.7

While the Board has always been active in controlling typhoid outbreaks, the first systematic effort to control provincial rates seems to have arisen simultaneously with the work reported upon in the "Progress Report" of the International Joint Commission on the pollution of boundary waters. The statistics which were prepared in connection with that report, in which, by the way, the Provincial Board had a large share, definitely showed that certain cities along our Great Lakes exhibited typhoid rates very much in excess of the provincial average. Investigations that were undertaken in connection with the water supplies showed clearly that the supplies were in an unsatisfactory condition.

The Board, in coping with the local situations on this side of the boundary, took advantage of the fact that chlorination of water supplies was being advertised as a cure-all, and every municipality showing a rate higher than the provincial average was persuaded, or forced if necessary, to install chlorination apparatus, which was supervised for a period. The results of these experiments demonstrated to the Board's satisfaction that certain of these cities on the Great Lakes had been and were acting as distributing points for typhoid fever. The improvement of the local situations, accompanying the administration of chlorine to the water supply, not only had an effect on the municipalities directly concerned, but the effect was also felt all over the province.

That this should be so may readily be conceded because of the fact that even though certain situations are

potentially dangerous, they will not yield typhoid fever until the organism is introduced from the discharges of people suffering from, or carrying, the disease. If the number of cases of the disease are diminished in the province, naturally there is a falling off in the number of coincidences whereby pollution might be introduced for water supplies not so protected.

Table 1 shows, therefore, not only a definite reduction in the typhoid rate of the cities, but it also definitely shows a general reduction in the provincial rate. The typhoid that we have now remaining with us seems to be more or less confined to the smaller towns, and to arise from wells and the occasional contamination of the milk supplies. Many of the persons recovering from typhoid fever continue to harbour the organism in the body waste for a number of years after recovery from the attack.

It is possible, then, to conceive of towns in which the prevalence of disease at one time or another has given rise to a considerable number of carriers, who in turn pollute the wells. There is a remarkable freedom, I am glad to say, from typhoid fever in towns which rely solely upon the municipal water supply.

Supervisory Function of Board.

The supervisory function, therefore, of the Board is mainly concerned in detecting and correcting conditions in centres which show rates that are unduly high. The Board is fortunate in that the Department of the Registrar-General is co-ordinated with that of the Board of Health.

Returning again to the question of just what is the duty of the Board: Granting that it had all the money that would be required, there arises the question, to what extent will the citizens tolerate the exercise of arbitrary power in matters upon which their information is lacking? What I mean to say is: Suppose the Board, vested as it is with extraordinary power, should proceed to exercise this power considerably in advance of local information and

local education (which is possibly another matter). The result would be—and it can be perceived every year when the House meets—that there is definite resentment of the authority vested in the Board. If this resentment were Province-wide instead of being confined to a few municipalities or a few individuals touched by the Board's activities, I have no hesitation in saying that there would be an effort, and possibly a successful one, to modify the Health Act radically, and to take from the Board the authority which has made possible the progress noted during the last ten years.

It must, therefore, be accepted that despite the authority vested in the Board, the exercise of that authority is limited because laws may be amended almost as readily as they are enacted.

It has been found necessary, where the Board wishes to impose arbitrary judgment upon a municipality, not only to inform itself of the facts, but also to give considerable publicity to the matter, in order that the citizens should have an opportunity of digesting the Board's conclusions and to re-adjust themselves to those conclusions, the evidence supporting which is not always as obvious as when one has an epidemic condition of disease.

Educational Campaigns

It must also be recognized that in these educational campaigns the Board is not only dealing with facts, but has to convince the citizens of its interpretation of the facts, and at the same time to persuade them to loosen the strings of their pocket-books, a matter requiring considerable diplomacy in itself. This latter phase of the matter of the pocket-book opens up a further question, and that question is, which work should take precedence,

*Paper read before the Canadian Section, American Water Works Association, Brantford, Ont., May 13, 1922.

and in this connection I think it is encouraging to note that the municipalities are spending large sums on the improvement of road surfaces, the extension of sidewalks and works of this nature. So it does not seem that a lack of funds is perhaps the paramount difficulty when one comes to discuss the question of the treatment of water supplies and of sewage disposal.

Over against the question of policy and precedence, there is perhaps a more important question, and that is of utility. Personally, as between water purification and sewage disposal, I have always been a firm believer in the treatment of sewage for further protection of the water works plants. At the same time, I cannot ignore arguments to the effect that sewage treatment as generally carried out and nominally supervised, does not afford the protection that the popular mind conceives to be the case.

The situation in Ontario is somewhat aggravated by the fact that our rivers and streams are in general fast-flowing, and as a result afford but little storage between the point of entrance and the point of withdrawal. This fact changes the whole complexion of the problem of protecting our water supplies. The storage of water has been relied on in the Old World for protection for a number of years. The work of Sir Alex. Houston of some fifteen years ago amply demonstrated wherein this protection lay, and he was able to show conclusively that the majority of the pathogenic organisms introduced through a water supply rarely lived longer than two weeks under ordinary storage conditions, and that a period of three weeks was almost absolute protection. Such storage as this is not to the writer's knowledge associated with any of the local situations confronting the municipalities in Ontario, so if reliance is to be placed upon sewage-treatment works, the works in themselves must render the effluent innocuous, and that involves intensive purification and sterilization, and no matter how practical these measures may be, there is no question but that they are expensive and that it is hardly within the province of the Provincial Board of Health to force an issue along such lines at this stage of the game.

Without wishing to dodge responsibility, I think, I can fairly say that in no instance has the Provincial Board initiated proceedings against a municipality for sewage treatment, behind which was not an order or ruling of the courts, or an agreement arising out of an action initiated from sources other than the personnel of the Board.

Standards Required For Effluents.

I presume that some engineers will not be satisfied unless I touch for a moment on the question of the standards required for the effluent from a sewage-disposal works. That some statement should be made is particularly pertinent in the minds of many, because of the fact that legislation leaves the matter clearly in the hands of the Board to determine.

It is very difficult to supply a satisfactory answer to such inquiries. An answer has been attempted in England, largely determined from the conclusions of the Royal Commission on Sewage Disposal, but the situation in England is radically different from that in Ontario. The streams are smaller; the uses to which the streams are put much more varied, and the intensity of pollution is very much greater in the Old World than in this. And while it may be conceded that some minimum standard might well be voiced by the Department, it appears impossible without hardship to set a standard which should apply Province-wide.

The situation is very complicated, especially in view of the fact that most of our greater water courses are international in character, and the pollution found therein, as has been concluded by the International Joint Commission, frequently rises on one side of the boundary to the injury of the health and property of the other. It would be a hardship, indeed, to impose sewage treatment on the Canadian municipalities along, for instance, the Detroit River, without similar restrictions being imposed upon the city of Detroit. Such a situation also holds true with reference

to the pollution existing in the lower Niagara River and the city of Buffalo.

For the more inland towns, local situations have largely governed the quality of the effluent demanded. Few of our streams are so small but that they can satisfactorily oxidize effluents which have been treated by any of the well-known biological processes. It is about bacterial pollution that the Board and riparian owners have chiefly concerned themselves of late.

The Board hesitates to support any active campaign for the chlorination of sewage effluents, for the reason that it is an extremely expensive undertaking and subject to interruptions which nullify very largely the benefits hoped for. The processes, therefore, which combine clarification, oxidation and sterilization are of particular interest to the Board.

It has been asserted that the Board is particularly biased with reference to the merits of the activated sludge system. I take issue with that conclusion. I admit that the Board and its engineers are thoroughly familiar with the process, having experimented with it continuously since 1914, and that they are exceptionally aware of its advantages and limitations. But the Board has also carried out intensive experimental work on the various types of distributing filters, both on an experimental scale and in connection with the numerous institutions operated by the Province, and I may say that this information is as complete as that with respect to activated sludge. The Board is also familiar with Imhoff tanks. At the Experimental Station we had in operation one of the first Imhoff tanks on this continent, in 1912, the results from the operation of which are similar to those obtained elsewhere.

The engineering department of the Board being, I hope, thoroughly informed of the various processes of sewage treatment, has been loth to recommend any particular type, except upon financial grounds or because of some special requirement of a local situation, determined either from the facts or from a court decision.

Of late the Board has taken the position that the consulting engineer or the municipal engineer in recommending a sewage disposal plant for a municipality shall state the estimated capital cost and also the annual operating charges of the system. Occasionally the Board has also required that a similar set of figures be computed for another type of plant when they are not furnished in the original report. If in the judgment of the Board the operating costs of the two systems, including the interest and the annual charges for retirement, are approximately the same, the Board naturally would favor that system which would yield the most satisfactory effluent. This attitude on the part of the Board is, I believe, the correct one, and I think many will admit that the Board is pre-eminently in a position to determine or advise as to which plant would yield the most satisfactory effluent, taking all factors into consideration.

Again the question may be asked, what is the Provincial Board of Health doing? If the Board has not taken the initiative in the matter of forcing the municipalities to undertake works for sewerage treatment, it has on the other hand assisted materially in simplifying the legislation whereby a municipality suffering a hardship may take action on its own behalf, and the Public Health Act recites clearly the extent to which the Board will assist or can be asked to assist in respect to such actions.

Laboratory Service.

In addition to the chief laboratory in Toronto, the Board now has branch laboratories in London (at the Institute of Public Health), Owen Sound (under George Murray Fraser), Peterborough (under A. Y. McNair), Kingston (under James Miller), Fort William (under N. O. Thomas), North Bay (under John S. Douglas), and Sault Ste. Marie (under N. F. W. Graham).

Besides these, there is also a laboratory at the Experimental Station of the Provincial Board in connection with the investigation of sewage and water. This is under the direction of the Sanitary Engineering Division.

Any of these laboratories are equipped and prepared to do water analysis and to determine definitely whether a given sample shows an alarming amount of pollution or not. This in itself is a considerable gain, in that it determines whether sanitary surveys are necessary to round up a source of undetected pollution.

TABLE 2—SUMMARY OF APPLICATIONS FOR APPROVAL OF DEBENTURE ISSUES IN CONNECTION WITH WATER AND SEWAGE APPROVED BY THE BOARD, 1915-21.

	Applications	Estimated Cost
1915	286	\$4,679,496.74
1916	190	2,010,079.42
1917	186	2,880,534.72
1918	146	1,590,658.39
1919	256	5,508,698.53
1920	262	7,359,659.50
1921	367	7,305,195.09

As well as a laboratory service the Board has been conducting sanitary surveys of the municipalities during the past three years and collecting information with respect to the extent to which public utilities such as water works and sewerage are being used, locating premises unconnected to sewers, and determining the number of closets and wells (private and otherwise.)

All of the information contained in the sanitary surveys is of particular interest in that they reveal conditions which may offer some partial explanation of why typhoid continues to exist in some municipality despite improved water supplies.

When this work was undertaken some three years ago, I anticipated finding conditions, which were not altogether satisfactory, but at the same time, I had no idea that so many premises were unconnected by either water works or sewerage in many of our larger towns.

The correction of the conditions revealed by surveys of this type naturally rests with the municipal authorities and with the local Boards of Health. It does not appear that the function of correcting these conditions should devolve upon the Provincial Board of Health, since it must be perfectly obvious that should the Board give its attention to details of this type, there would be no opportunity for covering those general fields of endeavor which in no sense fall within the province of the municipalities.

Research Work.

I shall conclude my argument as to what the Provincial Board is doing to protect the various water works throughout the Province from sewage contamination by stating that the Board has consistently, since the establishment of the Experimental Station, carried on research with respect to matter pertinent to the question, under discussion. Following is a rather incomplete list of some of the work which has been published.

"Factors in the Design, Regulation and Action of Slow Sand Filters," by F. A. Dallyn, April, 1913.

"Report upon the Purification of Sewage," by A. V. DeLaporte, 1913.

"Studies in the Behavior of Mechanical Filters," by C. S. Robertson, 1913.

"Studies in the Disinfection of Sewage by Calcium Hypochlorite," by C. R. Avery, 1913.

"A Comparison Between Bleach and Liquid Chlorine," by C. R. Avery, 1914.

"Does Alum Inhibit the Action of Chlorine as a Disinfectant," by C. R. Avery and O. G. Lye, 1914.

"Ultra Violet Ray Sterilization of Water," by F. N. Parkinson, 1914.

"Some Experiments in the Solubility of Alum," by Miss G. E. Gallinger, 1916.

"Report upon Filter Alum Used in Ontario," by Miss G. E. Gallinger, A. V. DeLaporte, and F. A. Dallyn, 1916.

"Desirable Features for Alum Feed Apparatus in Water Purification Plants," by F. A. Dallyn, 1916.

"Compilation of Recommended Methods of Physical and Chemical Examination of Water and Sewage," by A. V.

DeLaporte, 1918. (Revision in 1920, including interpretation of water analysis).

"Effect of Periods of Non-Aeration in the Activated Sludge Process of Sewage Purification," by G. A. H. Burn, 1921.

Practically all of these experiments deal with some particular problem which either has or is now confronting the Municipalities in connection with the operation of their water and sewerage plants.

Research not only makes available a certain amount of information for the public and the municipalities in general, but it has afforded the engineers of the Board an opportunity of obtaining first-hand information on many of the problems with which they are confronted. It gives, too, the Board an opportunity to train its men properly. The laboratory is recognized by the University, so students may proceed to their Master's degree from work carried on at the Experimental Station during the University year.

At the Experimental Station we are capable of carrying on experiments with respect to any type of water-purification equipment, and are completely equipped to carry on research in many forms of sewerage treatment. Not only do we obtain information as to the results from the various methods when they are working satisfactorily, but we obtain as well definite data as to results when the plant is operating badly. In addition, we get some sense of proportion as to what could be reasonably expected of plants of this type in view of the many factors entering into their design and the conditions under which they must operate.

And it is from information gleaned from such sources that the Board's action with respect to any particular situation is determined.

In summing up I would suggest that the Provincial Board is doing all that its present appropriations and the state of public opinion will permit it to do in connection with the protection of water works from sewage contamination, and that the contribution of the Government to this matter is roughly divided under the four headings that I have dwelt upon at some length, namely, supervision, legislation, laboratory service and research.

LARGE EXPENDITURES ON CANALS.

SINCE the beginning of construction a total of \$29,399,405.93 has been expended on the Welland Canal and \$30,787,977.90 on the new Welland Ship Canal. In the fiscal years from 1913 to 1922, inclusive, and ending on March 31 in each case, the following sums were spent: 1913, \$305,571.34; 1914, \$1,071,733.68; 1915, \$4,147,553.84; 1916, \$4,978,030.64; 1917, \$3,532,546.21; 1918, \$1,262,136.94; 1919, \$1,868,239.01; 1920, \$3,631,289.31; 1921, \$5,192,629.41; 1922, \$5,693,590.97; total, \$31,583,291.85. Of this sum \$203,005.60 was on construction on account of the present Welland Canal, and \$719,509.50 on improvement account. The balance of \$30,660,776.75 was on construction of the new Welland Ship Canal.

On the Trent Canal since the beginning of work on that waterway a total of \$20,702,514.80 was expended, of which \$18,849,361.11 was on construction account and \$1,853,153.69 for improvements. For the fiscal years ending March 31, from 1911 to 1922, inclusive, the following sums were expended: 1911, \$1,744,942.25; 1912, \$1,820,590.32; 1913, \$1,204,105.73; 1914, \$1,177,596.67; 1915, \$1,058,566.35; 1916, \$1,027,519.03; 1917, \$624,441.78; 1918, \$613,980.85; 1919, \$412,507.25; 1920, \$1,077,251.36; 1921, \$690,197.13; 1922, \$673,261.15; total, \$12,124,959.87. Of the latter sum \$10,889,063.51 was on construction account and \$1,235,096.36 on improvements.

Ontario has 27,117 miles of surfaced roads, made up as follows: Gravel roads, 23,166 miles; broken stone roads, (Macadam) 3,385 miles; broken stone roads with tar carpet coat, 266 miles; bituminous penetration pavement, 139 miles; asphaltic concrete pavement, 43 miles; cement concrete pavement, 118 miles.

PUMPING PLANTS FOR LAND DRAINAGE*

Reclaiming Land in Mississippi River Valley — Electrically Driven Centrifugal Pumps Often Used for Drainage Work — Advantage of Diesel Engines.

By L. C. Craig

Ast. Engineer, E. T. Perkins Engineering Co., Chicago

MANY acres of swamp and overflowed lands in the United States are so situated that they cannot be entirely reclaimed without pumping. This is especially true of the 20,000,000 or more acres in the Mississippi River Valley. During the last 25 years many drainage districts have been formed in the Mississippi River Valley, the first areas to be reclaimed being those so situated that all or a part of the drainage water would flow off by gravity. Gradually as the land increased in value pumping plants began to be installed more and more, as a part of the drainage systems. There exist today many areas with no drainage and others where only partial gravity drainage is obtained, where eventually pumping plants will be installed.

Only a few years ago \$20 to \$30 an acre was considered a big price to pay for the draining of agricultural land. Today, because of increased land value, many areas are being reclaimed at a cost of \$60 and more an acre.

Unfortunately, there exist today few reliable records concerning the capacity and efficiency of drainage pumping plants; such records, where found, usually extend back over a period of only a few years.

Many plants have been installed without adequate means being provided for making tests, or those in authority have failed to realize the necessity of such tests. In many cases no engineer is employed after the construction period.

Those matters are gradually being remedied and during the next few years we will see a very marked development of drainage pumping in this country.

A drainage area requiring pumping is usually one with the ground level, so low as to require the raising of the drainage waters over a dam or embankment to a higher level. This dam or embankment may be part of a levee system, constructed to protect lands from flood overflow, as is the case in most river bottom areas, or a dam and pumping plant may be placed in an ordinary drainage ditch at a point where, because of a very flat gradient or lack of outlet, it is found impossible to take care of the drainage waters by ordinary ditch construction.

Conditions Affecting Size of Plant.

The size of pumping plant required for any particular drainage area depends upon a number of varying conditions, among which are:

1. The size and topography of the drainage area.
2. The amount and distribution of rainfall.
3. The system of ditches and drains used, and the amount of storage capacity available in ditches and reservoirs.
4. The nature of the soil and sub-soil as affecting run-off and seepage.
5. The method of operation of the plant and the degree of drainage required.

The first three factors given above are, of course, the most important in the design of any drainage pumping plant, but all should receive consideration.

For the past 20 years, or more, in Central Illinois and along the Mississippi River pumping plants for removing water from flat drainage areas have been designed for a maximum pumping capacity sufficient to remove in 24 hours $\frac{1}{4}$ in. in depth of water over the entire area. In Holland and other European countries for a much longer period $\frac{1}{4}$ in. or a little more has been used as the maximum capacity for drainage pumping plants. Experience in recent years has not shown that the run-off coefficient of $\frac{1}{4}$ in. should be changed as a standard basis of design under

average conditions. But the engineer must be sure to give due consideration to all modifying conditions in each particular case.

All other conditions being equal, the small drainage area of only 1,000 or 2,000 acres will require a slightly larger pumping plant in proportion to its size than an area several times as large. Where some of the area is higher with steep slopes and impervious soil, the run off coefficient for this portion must be made greater; in some cases it will be twice as great.

The amount of rainfall in Central Illinois averages about 35 ins. per year. Of this amount measurements have shown that about 26 to 30 per cent appears as run-off. Rains of 2 to 3 ins. in 36 to 48 hours sometimes occur.

In many drainage areas considerable storage exists in lakes and sloughs which it may not be found desirable to drain. This storage capacity, in addition to the storage ordinarily afforded by the drainage ditches, will reduce the size of the required pumping plant. If there exists considerable areas of tiled land, additional storage will be afforded.

Influence of Soil and Sub-Soil.

The nature of the soil and sub-soil of the drainage area has a big effect on the run-off, and when the water on the outside of the levee the effect may be the opposite, and the high stage, on the amount of seepage. If the soil is a close, compact formation, the surface run-off will be heavier from a sudden rain. A sandy sub-soil underlying a drainage area is generally an advantage, because the necessity of constructing tile drains and many small lateral drainage ditches may be largely eliminated, but during high water on the outside of the levee the effect may be the opposite, and the amount of pumping increased by an excessive amount of seepage.

Levees exceeding 10 ft. in height are usually constructed with a muck ditch or small ditch excavation 4 to 8 ft. in depth, constructed under the base before the levee is built, so as to bind in and help consolidate the levee fill with the soil formation underlying the base, and levees, when so built, have been found to resist seepage in a marked degree. However even with a well-built levee and a sand or gravel sub-soil there will be considerable amount of seepage which rises to the surface of the ground inside the levee or may be intercepted by tile drain or surface ditches. Where such tile drain or surface ditches exist, located parallel to and adjacent to a levee so as to cut off and carry away the seepage, the amount of such seepage waters may be as much as 2 second feet per mile of levee.

A pumping plant should be designed to operate continuously if necessary. Generally, during the winter months little pumping will be necessary, because without growing crops little drainage will be needed, but it will be found to be an advantage to pump occasionally throughout the winter so as to reduce the ground water level and thereby secure an early drying of the soil in the spring. In this manner the run-off from heavy rain coming in the spring will be lessened and the size of the pumping plant which might otherwise be required may be reduced.

Type of Plant To Use.

After the amount of water to be provided for in the capacity of the plant has been decided on, we must next determine the type of engine and pump which should be used.

The importance of a well designed pumping plant cannot be overestimated. Many pumping plants have been installed in drainage districts along the Mississippi and Illinois Rivers which have been operating with very poor economy, because of poor design. In some cases both pumps and engines have been removed and others installed once or more in a period of 10 or 15 years.

A well designed pumping plant does not mean necessarily one having the greatest economy of operation. Usually from 60 to 80 per cent of all pumping is done in the four months March, April, May and June and during the late summer and fall months and in some localities no pumping at all is needed. It can readily be seen, therefore, that with the plant idle a good share of the time it might not

*Paper read at the National Drainage Congress, St. Paul, Minn.

be economical to spend a lot of money on costly equipment in order to secure economy of operation.

As a usual thing, in a well designed pumping plant using steam, the operating expenses are about half of the total cost including fixed charges. Where the operating expenses are much less than half of the total cost it will usually be found that the total cost should be reduced by using less costly equipment. The item of fixed charges, including interest, taxes, insurance and depreciation, should always be given full consideration in arriving at the total costs as in any other well designed plant installation.

As pumping plants must be depended upon to operate when needed and any delay may mean a flooding of large areas with resulting loss of crops, reliability is one of the chief factors governing design. Or, as a usual thing, it may be said that a type of pumping plant which has proved itself reliable and will require the least annual cost, including fixed charges, will be the best.

Types of Pumps Used.

Several kinds of pumps, including scoop wheels for low lifts, rotary, plunger and centrifugal pumps, are used in drainage pumping but the centrifugal pump has come to be recognized as best suited to conditions usually found in drainage work.

The number and size of the units to be used will, of course, depend upon the capacity and the conditions of operation. In order to have at least one pump in reserve in case of breakdown it is desirable to have at least 2 units, and one of these units should have about twice the capacity of the other, for the reason that the small unit will operate over longer periods with greater economy. This is especially desirable where steam is used as the source of power, as the frequent starting and stopping and firing up of boilers will necessitate the burning of much additional fuel, and shorten the life of the boilers. Where three or more units are used they should be of equal size. The total capacity of the pumps should be sufficient to pump the maximum quantity of water against a static head about 3 or 4 feet below the maximum expected.

Friction Head In Pipes.

In order to determine the actual or hydraulic head on the pump, we must add to the static head an amount which should not exceed 3 ft. in a well designed pumping plant. This additional head, called the friction head, is due to the friction in suction and discharge pipes, the velocity head and the losses at the entrance and outlet of these pipes.

In many poorly designed plants not enough attention has been paid to eliminating the losses in the suction and discharge pipes. The entrance to the suction pipe should be expanded so as to reduce the velocity to not more than 3 ft. per second; 2 ft. per second is better.

The centrifugal pump operates efficiently only when running at or near the speed which is suitable for reach particular head. Therefore, where the total head is variable, as in most drainage pumping, it is desirable to have some method of regulating the speed. This is accomplished in the case of the steam engine by regulating the speed of the engine and in the case of the constant speed induction motor by belt connecting to the pump and using two or more sets of pulleys, so as to secure the desirable speed. This latter method is cumbersome and undesirable and there is the further objection of loss of power with the belt drive.

With a pump properly designed it may be found that the source of power can be direct connected to the pump and any loss in efficiency in the pump due to the operation at constant speed will be offset by the elimination of the power loss with the belt drive. With variable speed drive or with the steam engine or internal combustion engine direct connected, it may be found that there will be losses in the engine itself, due to operation at less or more than rated speed, which will make changes of speed inadvisable. It is necessary, therefore, that the engineer, before designing a pumping plant, should make a thorough study of all data concerning the equipment he proposes to use, and if pos-

sible he should examine other plants where reliable tests have been made.

Pump manufacturers will usually furnish characteristic curves showing capacity brake horse power and guaranteed efficiency at various speeds. Curves should be drawn or computations made showing complete operating conditions, including the total quantity of water and the total number of horse power hours for various heads over a typical operating period of one year. These curves or computations should be compared with the characteristic curves of the pump to see that the pump has sufficient capacity and is so designed as to have a good efficiency while pumping the greatest quantity of water. From these data also the maximum horse power of the prime mover and amount and distribution of the fuel consumption can readily be determined.

In the case of variable speed drive a proposed operating chart should be made up, showing the proper speed and other operating conditions which should be used to secure greatest economy. The chart, of course, will be modified as found necessary by tests of the plant after construction.

Prime Movers For Pumping.

Steam engines, electric motors and internal combustion engines are all used as prime movers for drainage pumping. Which should be used, in any locality, depends upon the size of the plant its method of operation the cost of fuel delivered and the availability of competent labor.

In locations where soft coal can be obtained cheaply, steam may be an economical source of power. In large units one of the advantages of the use of steam is that better speed regulation of the pumps can be obtained. A disadvantage, of course, is the intermittent operation of the plant previously mentioned, and difficulty in delivering coal and supplies. In plants of over 200 h.p. it will usually pay to put in high speed automatic condensing engines with water tube boilers. Higher grade engines, such as the so-called "uniflow engine" with superheat, usually are found suitable only for plants of over 300 h.p. where the cost of operation is a much larger portion of the total cost than in a small plant.

Electric Pumps Preferred.

The electric drive has many advantages over other sources of power wherever electric current can be supplied at a reasonable rate. The two principal advantages are low first cost and convenience of operation. Usually the cost of an electric drive pumping plant will be about 60 per cent of the cost of a steam plant. Its depreciation is much less than any other form of plant. It can be operated with ordinary labor with few repairs, and in small plants its operation can be made automatic. The tendency during the last few years has been toward electric pumping.

Because of the low cost of fuel oil the internal combustion engine of the Diesel or semi-Diesel type is now receiving a great deal of attention as a source of power for drainage pumping plants. Up to about five or six years ago there were not over 6 concerns in this country building engines of the Diesel or semi-Diesel types. Now there are at least 16 builders of Diesel engines and at last 30 or more firms building various types of semi-Diesel or low compression engines.

Many of the types of internal combustion engines now being placed on the market are still in a state of development or have but recently passed that stage; therefore, before selecting this type of engine for a drainage pumping plant, the engineer should make a thorough investigation of the performance of engines which have been in operation at least two years.

Full Diesel Engines.

The full Diesel is an engine using high compression and high temperatures with complicated valve mechanism; needing an intelligent, skilled operator. Its first cost is also very high, and although very economical in fuel consumption, its use for drainage pumping is practically limited to large plants.

The semi-Diesel or low compression engine offers better possibilities I believe, for the small plant. This engine will develop a brake horse power hour on about 0.7 pint of fuel

oil as compared with about 0.5 pint for the Diesel engine. At present prices, oil of the grade required for these engines can be delivered in most any locality at a cost of from 3 to 4 cts. per gallon. The first cost of these engines at the present time is about \$50 to \$60 per horse power, about half the cost of the Diesel engine in small units.

There are various grades of oil used in engines of this type, varying from a gravity test of 20 to 44 deg. Baume. The trade name, fuel oil, is applied to all oil residue left after distillation has removed the gasoline, kerosene and light distillates from crude oil and varies in gravity from 20 to 32 deg. Baume. As oil varies in price, the lighter oils costing more, it is very important to be sure that the engine will run successfully on a low grade oil. Some manufacturers will guarantee operation on oil of a gravity of 24 deg. Baume; others will specify a higher grade. In some cases where the low grade oil is specified, there will be a very low content of sulphur or coke required or some other qualification which may raise the cost of the oil.

The writer recently had occasion to investigate the quality of fuel oil being used by a number of operators of semi-Diesel engines near Chicago, and found that none of them were using the low grade guaranteed by the manufacturers. The cost of the oil being used exceeded the cost of the low grade oil by from $\frac{1}{2}$ ct. to 2 cts. per gallon.

To be of use in a drainage pumping plant the engine must operate successfully at varying loads, and the regulation of fuel and water supply must be entirely automatic. Some semi-Diesel engines have trouble with their fuel and water regulation under varying loads and this is a matter that requires careful investigation.

With the increasing consumption of gasoline, it is fair to assume that there will always be a good supply of fuel oil and that the cost of this oil will always be low enough so that except in a few localities oil can be used successfully in a well designed engine in competition with coal or electricity. Many central stations are now using Diesel engines and producing electric current at a cost, including all fixed charges, of 2 to 2 $\frac{1}{2}$ cts. per kilowatt hour.

In conclusion, with reference to the use of the Diesel or semi-Diesel engine for drainage pumping plants, I will say that the development of this form of prime mover for stationary engines has not yet reached a stage where their use can be recommended without very careful investigation of plants now in operation, but I recommend that every engineer, before designing a pumping plant, investigate carefully the possibilities of this type of prime mover.

TIDAL RESEARCH WORK IN EASTERN CANADA

PEOPLE as a general rule are unacquainted with the method of obtaining information concerning tides. The system of reducing tidal observations is complicated and technical. The usefulness of the survey can, therefore, best be judged from the published results as shown in the annual tide tables issued by the Naval Department. These tide tables give the time of the rise and fall of the tide or the turn of the currents along the Canadian coasts for periods of one year in advance; that is, the time of the tides for 1922 may be obtained from the tide tables issued in the fall of 1921. The tide tables also give for various regions the height of the tide and the depth over certain areas at high and low water. The information is valuable to shipping interests as they are enabled to know the depth of water over bars and shoals at the entrances of our harbors at any stated period. The information compiled by this survey is also useful with regard to mean sea level which is determined by them and which is used by land surveyors as the basis of their levelling operations.

The record of tides is obtained by use of an ingenious instrument actuated by clockwork. This instrument gives a continuous curve which shows the height of the tide at every moment throughout the day and night, and thus records more accurate information than could be obtained by three men set to observe the tide in eight-hour shifts during the 24 hours of each day. These instruments, to

give correct results, must be carefully installed and must also be kept accurately set.

The tidal records compiled by the Canadian Government have now reached a high standard of perfection and Canada is well in the lead in recognizing the importance of tidal information not only for navigation purposes but also as a basis for carrying out levelling operations and survey work on land.

Extensive tidal research work has been carried on by the Tidal Survey Branch of the Naval Department during the past summer. This work was performed in order to obtain additional tidal data over that compiled in previous years for our harbors and various other areas for which tidal information is required.

During the past year observations of the tide were made at Campbellton and Dalhousie at the head of Chaleurs Bay and other harbors in eastern New Brunswick, where the tide is of special importance because of bars at their entrances. At these harbors, considerable dredging has been done, or is in prospect. Tidal data are essential in relation to low-water levels and the amount of rise of tide where the depth of water available for navigation is limited. The tidal data will facilitate the determination of what amount of dredging is necessary.

Three new tidal stations were put in operation at the entrance to the St. Lawrence, i.e., at Gaspé, Fox River and Seven Islands. Tidal data were also obtained for the east coast of Hudson Bay and for James Bay. In addition to the special work undertaken, the six permanent tide stations on the East Coast have been continued and from the reduction of the records obtained will be compiled tide tables for future years.

BRITISH FIRM EXTENDS HYDRO-ELECTRIC DEPT.

IN May, 1920, Sir W. G. Armstrong, Whitworth & Co., Ltd., initiated a hydro-electric section as a part of their civil engineering department, to secure orders for water turbines to be manufactured at their Elswick Works to the designs of a well known Norwegian firm.

The volume of business laid before the hydro-electric section, since it was first established was such as to cause the Board to decide to form a separate hydro-electric department, as a unit apart from the civil engineering department, as from January 1, 1922. The new department, like the old hydro-electric section, is dealing with complete water power development schemes throughout all the various stages, no less than with the various component parts of such schemes, civil engineering, mechanical and electrical.

Messrs. Armstrong, Whitworth & Co. now have survey parties out in many parts of the world looking into projects which have been brought before them for submission to the powerful financial group with whom they are working in the city of London, and it can only be anticipated that the part they will play in the coming era of intensive hydro-electric development in the Empire will be a very important one, and not only in the Empire but in all parts of the world.

The offices of the hydro-electric department are at 8, Great George Street, Westminster, London, S.W.1, and the department is under the management of Douglas Spencer, who is assisted by such well known hydro-electric engineers as Robert P. Tod, V. Bataillard and a large staff of British engineers.

An agreement has been reached between the reorganized Nipigon Fibre, Pulp and Paper Co. of Fort William, Ont., and the Ontario Hydro-Electric Commission by which that concern is to take 10,000 h.p. at a price of \$18. The contract, it is announced, will be signed as soon as a bond, provided for in the agreement, is put up by the company. The concern is to increase its capacity from 35 to 100 tons a day. As the power purchasers agree to take a certain proportion of the energy by July 1, immediate commencement will have to be made on operations to enlarge the company's plant.

AMERICAN WATER WORKS ASSOCIATION

Annual Convention Held in Philadelphia — Representative Exhibition of Materials — Detroit Next Year.

MORE than 1,000 members and guests registered at the 42nd annual convention of the American Water Works Association, held May 15 to 19 at the Bellevue-Stratford Hotel, Philadelphia, Pa. Among the Canadians present were the following:



W. S. CRAMER
President, American Water Works Association

W. H. Randall, Toronto; R. L. Dobbin, Peterboro; J. J. Salmond, Toronto; C. W. Schiedel, Waterloo; Geo. Geddes, St. Thomas; Marcel Pequegnat, Kitchener; Charles Warder, Niagara Falls; A. Collins, Niagara Falls; Alex. Milne, St. Catharines; N. M. R. Wilson, Brantford; F. W. Frank, Brantford; Thos. R. Logan, Brantford; Norman J. Howard, Toronto; C. D. Brown, Walkerville; D. McLean Hanna, Windsor; Thos. Hodgkinson, London; A. M. Bowman, Elmira; J. K. Van Gorder, Toronto; W. C. Miller, St. Thomas; A. F. McLachlin, St.

Thomas; John Hainsworth, Kitchener; W. H. Bradburn, Peterborough; B. R. McKenzie, Windsor; W. Gesses, St. Thomas; A. Collins, Niagara Falls; A. T. McLachlin, St. Thomas; and Prof. Peter Gillespie, Toronto.

Canadians Hold Luncheon.

Thirty-eight Canadian delegates and friends held a luncheon in the Blue Room of the Bellevue-Stratford Hotel on Thursday, May 18, and heard addresses by President Cramer and Secretary Diven of the American Water Works Association. The Canadian members then went into conference and in an informal way discussed matters affecting the Canadian Section, with special reference to the holding of the annual meeting next year in Windsor, Ont., and the advisability of holding a winter meeting in Toronto some time in February. The discussion brought out expressions of opinion as to how the Canadian Section can render the greatest service to water works operators throughout the Dominion.

Gracefully withdrawing from the race for next year's convention, San Francisco narrowed the choice in the executive committee to Omaha and Detroit, the latter then winning easily on the floor of the convention.

Nominations and Elections.

The following members were elected as the nominating committee: Beckman C. Little, chairman ex-officio; James J. Salmond, Toronto, representing District No. 1; J. H. Caldwell, Troy, District No. 2; W. R. Edwards, Paterson, N. J., District 3; Dow R. Gwinn, Terre Haute, Ind., District 4; John Chambers, Louisville, District 5; J. J. Hinman, Jr., Iowa City, District 6. The slate elected by this committee was endorsed on the floor of the convention without competition or even rumor of a second ticket, and the complimentary vote received by the new officers was high considering that it was only a formality.

W. S. Cramer, chief engineer of the Louisville Water Works, will be the president for 1922-3; George W. Fuller,

a well-known consulting engineer of New York City, will be vice-president; William W. Brush, treasurer; Geo. W. Batchelder, trustee from District No. 1; Joseph W. Ellms, trustee from District No. 4. Re-elected trustees are H. F. Huy, R. J. Harding, G. C. Gensheimer and J. Chris Jensen.

At a meeting of the American Water Works Manufacturers' Association, the following new officers were elected: President, Edgar J. Buttenheim; vice-president, C. R. Wood; secretary, John A. Klenle; treasurer, Dennis O'Brien. The following firms were elected as members of the executive committee: "American City," Wallace & Tiernan; E. I. Dupont de Nemours Co.; Pittsburg-Des Moines Steel Co.; and H. Mueller Mfg. Co.

Edward Cole, president of the Pitometer Co., New York, was elected chairman of the New York Section of the association. Burt Hodgman, chief engineer of the National Water Main Cleaning Co., New York, was re-elected as secretary.

Entertainment.

Approximately eight hundred of the delegates enjoyed a sail down the Delaware River, as far as Chester, on Wednesday afternoon, May 17. The boat returned at 5.30 p.m., and that evening the ladies attended a theatre as guests of American Water Works Manufacturers' Assoc.

Exhibits.

Sixty-eight firms occupied booths in the exhibit room, which was beautifully arranged. The show of water works materials was the most complete and representative ever seen at a meeting of the association. "Better than ever" was the unanimous opinion regarding both the exhibit and the convention. The exhibitors were:

Payne Dean, Ltd., New York; Rensselaer Valve Co., Troy; Water Works Equipment Co., New York; "The American City," New York; Mathieson Alkali Works, Inc., New York; Pittsburgh Meter Co., East Pittsburgh, Pa.; "Public Works," New York; Pennsylvania Salt Mfg. Co., Philadelphia; Central Foundry Co., New York; "Fire and Water Engineering," New York; Van Gilder Water Meter Co., Atlantic City, N. J.; A. P. Smith Mfg. Co., East Orange, N. J.; Thomson Meter Co., Brooklyn, N. Y.; Union Water Meter Co., Worcester, Mass.; Pittsburg Des Moines Steel Co., Pittsburgh; National Tube Co., Pittsburgh; Lead Lined Iron Pipe Co., Wakefield, Mass.; Birch Pump Valve Co., Chicago; East Jersey Pipe Co., New York; De Laval Steam Turbine Co., Trenton, N. J.; Pitometer Co., New York; Kennedy Valve Mfg. Co., Elmira, N. Y.; Buffalo Meter Co., Buffalo; National Water Main Cleaning Co., New York; National Meter Co., New York; Sullivan Machinery Co., Chicago; Gamon Meter Co., Newark, N. J.; Eddy Valve Co., Waterford, N. Y.; Neptune Meter Co., New York; Layne & Bowler Co., Memphis, Tenn.; "Engineering News-Record," New York; W. & L. E. Gurley, Troy, N. Y.; Chicago Bridge & Iron Works, Chicago; Electro-Bleaching Gas Co., New York; Wallace & Tiernan Co., Inc., Newark, N. J.; United Brass Mfg. Co., Cleveland; R. D. Wood & Co., Philadelphia; "Engineering & Contracting," Chicago; Builders' Iron Foundry, Providence, R. I.; Hersey Manufacturing Co., South Boston, Mass.; Ludlow Valve Mfg. Co., Troy; Badger Meter Co., Milwaukee; Glauber Brass Mfg. Co., Cleveland; Hayes Manufacturing Co., Erie, Pa.; Leadite Co., Philadelphia; Ross Valve Mfg. Co., Troy; Simplex Valve & Meter Co., Philadelphia; E. I. DuPont de Nemours & Co., Inc., New York; W. P. Taylor Co., Buffalo; Worthington Pump & Machinery Corporation, New York; Lock Joint Pipe Co., Ampere, N. J.; Columbian Iron Works, Chattanooga, Tenn.; U. S. Cast Iron Pipe & Foundry Co., Burlington, N. J.; American Manganese Bronze Co., Holmsburg, Philadelphia; New York Continental Jewell Filtration Co., Nutley, N. J.; H. Mueller Mfg. Co., Decatur, Ill.; H. W. Clark Co., Mattoon, Ill.; "The Canadian Engineer," Toronto; Roberts Filter Mfg. Co., Darby, Philadelphia; Ford Meter Box Co., Wabash, Ind.; Permutit Co., New York; Garlock Packing Co., Palmyra, N. Y.; Warren Foundry & Machinery Co., New York; M. L. Bayard & Co., Inc., Philadelphia; International Filter Co., Chicago; Pittsburgh Testing Laboratory, Pittsburgh; A. T. Taft Mfg. Co., Cleveland.

REHABILITATION OF OLD PIERS TO REDUCE THE COST OF HANDLING FREIGHT*

Problems to be Considered in Constructing Piers and Handling Freight — Elaborate Scheme Proposed For Freight Terminals for Manhattan

By Francis Lee Stuart,
Vice-President, Am. Soc. of Civil Engineers.

DURING the last few years, there has been such wastage of capital expenditure and of the prime necessities of civilization, that one of the problems of this generation, is the proper use of such capital, as is now available, for the greatest benefit to mankind.

The engineer is essentially a creator of ideas, a creator of ideals, and a constructor of values; and today, more than ever, must he use his trained judgment to get the best out of existing structures and study the possibilities of rehabilitating present facilities, before he recommends or sanctions their destruction and replacement by new and supposedly more economically operated facilities.

Necessary new facilities, addition to present structures, and change of methods, all have their justification, but of all possible improvements to property the one that destroys existing facilities is the one that requires the greatest thought.

Because of the changing character of the business of a port this is particularly true of piers, and to such an extent, that there are very few cases where the destruction of an existing pier, seems to me, to be justified under the present world conditions.

To cut down operating expense is a desirable aim in any business and often its accomplishment is the difference between success and failure in the undertaking. In port matters, the competitive character of the various ports, makes such a reduction a necessity at times to induce or retain business.

Early in our history, vessels were berthed at quays, and later piers were built to allow for berthing a greater number of sailing vessels per linear foot of water-front than the quays afforded. These piers were narrow and seldom 100 ft. wide. This old policy of narrow piers has been repeated down through the ages, until today it is usually a false economy and the greater number of berths of the narrow piers are secured only by the sacrifice of quay or wide pier economies in handling cargo and quick turn around of ships.

The large cargoes of the present day, the machines used as substitutes for manual labor, and the necessity for the intensive use of the pier in order to get a proper return on the increased value of pier properties, often require the rehabilitation of these old piers to reduce the operating costs of transfer from land carriers to vessels and vice versa.

In dealing with this many sided problem, the writer has taken but a few of its phases for the purpose of discussion. Bulk cargo requires special piers with suitable machinery and is not under discussion.

Narrow Piers.

Case 1. A pier 600 ft. long and 100 ft. wide for handling general cargo and the necessity to get greater returns therefrom. It will berth two vessels, generally it should not be lengthened for four berths on account of its narrowness, rails on such a pier would be a nuisance, it is too narrow for cranes, and it is too narrow to work advantageously the outboard, until the inboard is off the deck.

The suggested addition would be the building of storage areas, such as warehouses or sheds, inshore, for the receipt of import and export freight, instead of using the railroad cars for such storage. The freight, which it is not practicable to transfer directly from vessel by tractor and trailer to cars, can be stored in such warehouse or shed,

and later distributed as needed to destination; and the freight, which it is not practicable to unload from arriving cars and carry direct to ship side, will be stored in warehouse and later taken by trailer to shipside. The object being to use the vessel, the cars, the tracks, the tractors and trailers, and the warehouses or sheds, as one unified plant to reduce the gross expenditure of money for operation.

Such an arrangement of storage addition to a pier, releases cars quickly, cuts down trucking cost, speeds up the turn around of the ship, and makes many economies in operation, usually all well worth the capital additions for the warehouse and sheds, even if the pier is narrow.

Group of Narrow Piers.

Case 2. Consider a group of piers, say three or four, of old narrow dimensions, with high operating costs; these can often have their value and efficiency cheaply increased, by the construction of a group of storage sheds or warehouses inshore, as described above, any part of which can be used as an auxiliary to anyone of the piers.

Baltimore Type of Pier.

Case 3. If physical conditions permit, the space occupied by a group of piers can, in some cases, be bulkheaded and filled in, in the shape of a self contained pier or terminal, say 1,000 ft. deep and 1,500 ft. wide with berthing spaces on three sides of the rectangle.

The idea embraced in such a marine terminal is a central storage area with compactly located tracks and platforms and cheap but efficient one storey warehouses surrounded on three sides by vessels and so designed and with facilities so laid out, that freight can be moved by direct routes and without fouling from any location in the storage area to any vessel berth.

On the sides and face of the pier are located double or single deck dock sheds, set back a sufficient distance from the bulkhead for the use of cranes or other machinery as well as Burton poles (pier masts).

In the interior of the pier, there are provided storage platforms or single storey sheds, ranked perpendicular to the face of the pier. Such sheds will be separated on one side by sunken railroad tracks and on the other side by street driveways. The sheds are to be divided into separate compartments by fire walls, and on the outside of the sheds on each side there should be built longitudinal runway platforms for use of tractors and trailers.

In the middle of such a terminal, for economy in operation, there will be cross gangways extending from the bulk-head shed on one side of the terminal to the bulkhead shed on the other side, such gangways crossing the sunken tracks and roadways on moveable bridges. As the terminal becomes busier, elevated cross galleries connected with the platforms by elevators could be used for a similar purpose.

In operation, such a typical pier terminal is served by tractors and trailers, and city trucks can reach all parts of the plant. The berths on the sides are to be equipped with light gantry cranes, straddling two flush tracks. The cargo of incoming ships is to be unloaded on upper deck of double deck dock sheds, and to be delivered to cars or to warehouse, via cross galleries, by tractors or trailers; the outgoing cargo is to be transferred from cars or brought from warehouses by tractors or trailers and loaded from lower deck.

On the front of pier the berths have one flush track and all will be served by Burton Poles (pier masts). The incoming cargo will be unloaded on upper deck and thence distributed by tractors and trailers, via galleries or platforms, to cars or warehouses; and outgoing cargo brought from cars or warehouses by tractors or trailers, will be loaded from lower deck.

The plan lends itself readily to any mechanical installation, such as belts or overhead runways from one or any number of berths. The average haul from the warehouses to the berths is several hundred feet shorter than to same number of pier type berths, and each berth is more

*Paper read at a meeting of the American Society of Mechanical Engineers, April 28.

effective than a pier berth, and with much less first cost per berth than the pier type of berth. The system of vessel berths, tracks, roadways, transfer sheds, storage areas, galleries, platforms and runways are in such relation to each other that they allow uninterrupted forward, backward and cross movement of materials with short average haul and forms a manufacturing plant for transfer of cargo from one carrier to another, which should result in large reductions in gross handling costs.

This idea has been patented in order to maintain unimpaired the underlying principles, as explained above, and out of fondness for the city I propose to call it the "Baltimore Type" of Pier.

Case 4. A large portion of water front of a port can be rehabilitated in a way which may defer the destruction and rebuilding of existing piers. Warehouse, belt lines, a change in methods of the port—one or all three may be the desirable means of accomplishing this end.

Hudson River Water Front.

Case 5. Late, as consulting engineer of the Hudson River Bridge Co. I have been studying as a part of that project, an interesting concrete example of this case,—the Hudson River water front of Manhattan.

Many dock commissioners of New York City have had plans to tear out piers on the waterfront and to replace them or otherwise change the existing structures. The New York and New Jersey Joint Commission, before the New York Port Authority was formed, published suggested changes of such water front, of widened piers, replaced slips, lengthened piers, etc.

In nearly all cases the proposed piers were to be replaced by water, larger and more up-to-date structures.

Such destruction, such replacement with better structures, etc., can be deferred by additions to the present waterfront property of the facilities which are under consideration in connection with the Hudson River Bridge undertaking.

The Hudson River Bridge is primarily to take care of the vehicular traffic of Manhattan. It is estimated that such traffic alone will support the Bridge proper.

The project is to be built by private capital and will cater to such other business as seems fitting under its charter and which will furnish revenues, which will add to the profit of the undertaking or reduce cost to all users.

On account of the length of the span it requires great width and depth of the floor system to meet the structural requirements of rigidity, and advantage has been taken of this, to work out a lower deck with a capacity to carry 12 railroad tracks which can furnish, when as found desirable, facilities for three other public needs, viz:

- 1st. Tracks for rapid transit suburban trains from New Jersey.
- 2nd. Tracks for passenger trains, other than for commuters, to a Union Station in Manhattan.
- 3rd. Tracks for freight deliveries direct to Manhattan.

Each or any one of these three facilities can be an independent unit, built and maintained and operated as a separate unit, as and when economically justified; or a combination of two or all three of the facilities can work together with resulting economies from such a combination.

Proposed Manhattan Freight Terminal.

The freight terminal proposed in Manhattan consists of a freight elevated railroad located on blocks, lying on the east side of West Street from 46th Street to Cortlandt Street. These elevated running tracks are encased in an almost continuous building, extending about $4\frac{1}{2}$ miles from 42nd Street to Cortlandt Street, the building being 200 ft. wide and five or more stories high. The cross town streets pass uninterrupted through the building to the marginal way.

The main or running tracks for both inbound and outbound traffic, switching and platform tracks and car loading platforms are located on the first and second floor of building.

The street floor is to be utilized for the delivery of freight to and from trucks. The floor above the track levels is to be used as a main freight house floor for temporary storage of such freight as will be transferred immediately from one carrier to another such as cars, trucks, etc. Above this there are to be two additional warehouse floors or lofts.

It is proposed that team track terminals occupy a number of entire blocks between 39th and 25th Streets.

The freight that is to be handled is L.C.L. freight and such full car load freight as will not be handled at the team tracks.

The operation of the marginal and team track terminals is conceived on the principle of one way traffic around loops and avoidance of fouling of traffic by crossover and backup movements. For this purpose the terminal is divided into two sections, one north of 14th Street and the other south of 14th Street. All traffic for the portion north of 14th Street passes around a loop of 14th Street without interference with traffic, which passes through to the section south of 14th Street; and all traffic for the latter section passes around the loop at Cortlandt Street.

For the purpose of terminal operation the marginal terminal will be divided into individual terminal units, each about 1,300 ft. long. Cars will be classified on the New Jersey side for these various terminal units. Car load lots inbound for individual terminal units will be delivered to the Terminal Company in New Jersey and delivered by them later to the Manhattan Terminal in standard cars without breaking bulk. Less than car load lots will be transferred to containers in New Jersey by original road or by operating company and then delivered to Manhattan.

Vice versa, outbound car load lots will be loaded direct into standard cars, and L.C.L. will be loaded into containers and moved to New Jersey to be classified, or transferred at Manhattan Terminal into proper road cars of the forwarding company.

The freight at Manhattan Terminals is to be handled largely by tractors and trailers or containers over the platform and by elevators between various floors, on the principle of one way traffic and avoidance of fouling. The trucks handling the street platforms for delivery of freight to and from terminals are similarly operated on the same principle of loops and with the proper use of all cross streets to disperse the traffic into the city without congestion.

One of the compelling reasons why this terminal was located along the east side of West Street and which had a great influence on the general design of the terminal, was the possibility of rehabilitating and rejuvenating the entire front of Hudson River between Cortlandt Street and 46th Street, and furnish large additional capacity to the existing piers.

The marginal terminal is provided with elevated galleries crossing West Street connecting the warehouse with the piers so that freight to and from the Terminal can be transported direct to and from shipside by tractors and trailers.

While it is believed that heavy cargo steamers must eventually seek the rail head connection in New Jersey, the Hudson River waterfront is used principally for steamers carrying passengers primarily, and incidentally high class freight. It is expected that such use of the waterfront will increase largely with such facilities as are contemplated.

Some portion of the cargo of these passenger ships will come by lighter but a growingly larger part can be brought direct by the railroad to the individual terminal units or section of the terminal opposite the vessel's pier, and the freight can be unloaded at the freight platforms as a terminal work and carried by trailer into an upper warehouse floor of the part of the terminal warehouse and held until called for by the ship's stevedores or vice versa. Or instead of passing such freight through the general warehouse floor a pier owner could lease a floor or floors of any size required, to handle such work through their

own agencies, and even bonded warehouse could be provided for unloading inbound cargo into.

Such a treatment of the problem is exceptional and as far as I know only justified in this section of Manhattan, but it is my opinion that in this case the proposed freight terminals in Manhattan will add greatly to growth of the shipping interests as well as the business interests of the port and with a very large saving in gross handling cost, as well as profit to the undertaking.

In addition to the physical treatment of these cases, there is a public field of vision which must be considered.

The economic value of the expenditure to the contributing community as well as to the owner and the amortisation policy used.

The justification of the proposed addition to the facilities of the port and of the section of the country tributary to the port.

The use of rates for zoning or other means for artificial divisions of the country to get the greatest benefit from the use of certain parts; these and many other influences must be considered.

It is a far cry from the physical rehabilitation of old piers to cut down cost of handling freight, to a proper interpretation of the value of these economic features, yet they have a very important bearing on the correct decisions and are stated here in closing to remind you of some of the public aspects of the problem which should be considered for the benefit of your clients.

MODERN CONCRETE PROPORTIONING

MEMBERS of the Halifax Branch of the Engineering Institute of Canada held a special meeting at the Nova Scotia Technical College on Wednesday evening, May 10, to listen to an address by Lt.-Col. H. C. Boyden on "Recent Developments in Concrete." Col. Boyden is a member of the engineering staff of the Portland Cement Association. His lecture summarized the results of investigations carried on under the direction of Prof. Duff Abrams of the Lewis Institute, Chicago, for that association.

Col. Boyden stated that the Portland Cement Association had reached the conclusion that concrete proportioning must be put on a more scientific basis in order that the resulting concrete should have a definite pre-determined strength. With this in view, Prof. Abrams had been selected by the association to take charge of laboratory investigations at the Lewis Institute. His instructions had not been very specific. He was simply to investigate concrete. He was not hampered by a time limit nor by lack of funds. His first report was not made until three years after beginning his investigations.

As a result of these investigations, said Col. Boyden, it was found that the older systems of concrete proportioning are inaccurate, and that instead of specifying a 1:2:4, 1:1½:3 or 1:2½:5 concrete, one should specify that at the end of 28 days the concrete should develop a strength of 2,000 or 3,000 lb. per square inch, or such strength as the work might require.

It was found that the water content is an important factor in concrete; a factor practically ignored by most specifications. In determining the proportions for a mix a factor known as the fineness modulus was computed from the sieve analysis of the aggregate. It was found that mixtures of fine and coarse aggregates having the same fineness modulus required the same amount of water to produce concrete of the same workability and give concrete of the same strength. The water is expressed as a function of the cement, a certain water-cement ratio giving a definite strength.

"Relative consistency" is measured by the slump test on a 12-in. cylinder of freshly mixed concrete. That quantity of mixing water that causes the cylinder to slump about one inch when the mould is withdrawn gives normal consistency, or relative consistency of 1.00. If a certain water-cement ratio produces a certain strength for a certain "relative consistency," and a wetter mixture is desired, the

same strength to be produced, then more cement must be added to keep the water-cement-ratio the same as in the drier mix. Thus a wet mixture, such as that used when the concrete is distributed by chutes, requires more cement, which means more expensive concrete. In deciding, therefore, whether to deposit the concrete by chutes, the saving thereby effected must be balanced against the added cost of the extra cement.

Col. Boyden is of the opinion that the scientific methods being evolved at the Lewis Institute will eventually supplant the present methods of concrete proportioning. At the present time some architects and engineers are specifying that the concrete should be proportioned, not by arbitrary quantities, but in such a way that a certain strength be attained at 28 days. Experiments have shown that a certain predetermined strength can be easily obtained within 10%, especially after one becomes accustomed to the methods employed.

Following the lecture there was a very interesting discussion. Col. Boyden stated that tests have shown that the strength of concrete does not depend on the hardness of the coarse aggregate. Tests have also shown that many "hardeners" and waterproofing powders are of doubtful value. The addition of one-thousandth part (by weight) of tannic acid to clean sand has seriously weakened the resulting test specimen, thus showing the harmful effect of organic matter in sand, even when present in very small quantities.

WELLAND CANAL PROGRESS

ABOUT 70 per cent. of the total construction work on the new Welland Ship Canal yet remains to be done. The work still to be done comprises the completion of sections 1, 2, 3, 4 and 5; the construction of sections 6, 7, 8 and 9; the lock gates, super-structure of bridges and minor details. The work completed comprises 63 per cent. of the work on sections 1 and 2; 51 per cent. of the work on sections 3 and 4 and 72 per cent. of the work on section 6.

The gross amount expended on the canal work up to March 31, 1922, was \$30,588,026.07, less a credit for cash received on account of the plant and materials, etc., from contractors for sections 1, 2 and 5 of \$1,147,761.25, less a further amount to be paid by contractors for sections 1, 2 and 5, in accordance with their contracts on account of plant, etc., totalling \$952,883.11; less a further \$2,151,655.88, which is the estimated value of plants, etc., to be taken over by contractors for sections 3 and 4, leaving a net expenditure on the work to March 31, 1922, of \$26,333,725.83, which sum includes other redeemable assets.

If ample funds are available for the purposes of the work the canal will be ready for traffic during the year 1927. At any rate, the Government will finish the work as soon as possible, and this year it will proceed with the construction of locks on sections 1, 2 and 3, and excavation on sections 1, 2, 3, 4 and 5.

Criticising the building codes and declaring that many designers of structures were dwelling too much on the element of safety because they were afraid to come forward and demand from contractors the proper concrete, Lieut.-Col. H. C. Boyden spoke before the Engineering Institute of Canada, Montreal branch, recently, on "Recent Development in Concrete." He said the failures in concrete buildings which have taken place are due to a disregard for the fundamental laws. These laws have been thoroughly proven, he said, and theories have now been replaced by facts.

According to information received in Victoria, J. G. Sullivan, late chief engineer of the Canadian Pacific Railway will shortly be appointed to act as engineer in the investigation of the Pacific Great Eastern Railway in accordance with the announcement made by Premier Oliver at the last session of the British Columbia legislature.

OFFICIAL PROGRAM FOR GOOD ROADS CONGRESS

OFFICIAL programs of the ninth annual convention of the Canadian Good Roads Association to be held in Victoria, B.C., from June 12 to June 15, have been sent out by George A. McNamee, secretary, to federal and provincial members of parliament, municipal councils and engineering, good roads and automobile organizations. The eastern delegation to the convention, which will comprise representatives of the Maritime provinces as well as of Quebec and Toronto will leave Montreal and Toronto on Tuesday evening, June 6, arriving at Victoria on June 10, and other delegations will join up en route so that the good roads' enthusiasts will arrive in Vancouver together.

The special railroad rates available for the convention will be interchangeable on both the C. P. R. and the C. N. R. and will be good for returning until October 31, so that visitors will have an excellent opportunity of seeing the country and making a circular tour. The chairman of the Entertainment Committee is J. L. Beckwith.

Monday, June 12.

9.00 A.M.—Registration of delegates and visitors at Convention headquarters.

First Session.

10.00 A.M.—Congress called to order by the president of the Canadian Good Roads Association, Hon. Sam. J. Latta, minister of education, Province of Saskatchewan.

Second Session.

2.30—Address by Presiding Officer: Hon. Sam. J. Latta, president, Canadian Good Roads Association.
Address by Hon. J. H. King, minister of public works, Ottawa, Ont.

Address by Hon. S. F. Tolmie.
Paper: "Experiments in Improving and Maintaining our Prairie Roads," by Prof. K. A. Clark, University of Alberta.

Discussion by M. A. Lyons, chief engineer, Manitoba Good Roads Board.

Paper: "Drainage Methods for Prairie Roads" by Professor of University of Saskatchewan.

Discussion by C. W. Dill, superintendent of highways, Province of Saskatchewan.

Paper: "Bituminous Treatment of Gravel and Sand Roads," by A. B. Fletcher, state engineer, Sacramento, Calif.
Discussion by chief engineer, Province of Alberta.

4.30 P.M.—Appointment of Nomination and Resolutions Committee.

8.00 P.M.—Good Roads theatre party.

TUESDAY, JUNE 13.**Third Session.**

10.00 A.M.—Presiding Officer, J. L. Beckwith, Victoria, B.C.
Address by A. W. Campbell, commissioner of highways, Dominion Government.

Address by Hon. P. J. Venlot, minister of public works, New Brunswick.

Paper: "How to Improve Earth, Clay and Sand Roads," by J. D. Robertson, deputy minister of public works, Alberta.

Paper: "Gravel Roads," by A. R. Hirst, state highway engineer, Wisconsin.

Discussion by B. M. Hill, chief engineer, highways department, New Brunswick.

Fourth Session.

2.30 P.M.—Presiding Officer, J. A. Duchastel de Montrouge.
Address by Hon. J. L. Perron, minister of roads, Quebec.

Paper: "Cement Concrete Roads," by James Allen, supervisor of state highways, Olympia, Wash.

Discussion by A. E. Foreman, district engineer, Portland Cement Assn., Vancouver, B.C.

Paper: "Road Machinery," by F. L. MacPherson, department of public works, Victoria, B.C.

Discussion by Geo. Hogarth, chief engineer, Province of Ontario.

3.30 P.M.—Annual general meeting Canadian Good Roads Association, Reception of annual report, financial statement, auditor's report, and election of directors and officers for the ensuing year.

Paper: "Colonization Roads," by W. F. Fullerton, superintendent of colonization roads, Ontario.

8.00 P.M.—Informal Reception of Delegates at Government House, by Hon. W. C. Nichol, Lieutenant-Governor of the Province.

WEDNESDAY, JUNE 14.**Fifth Session.**

10.00 A.M.—Presiding Officer: S. R. Henderson, president, Manitoba Good Roads Assn.

Address by Hon. F. C. Biggs, minister of highways, Ontario.
Address by Patrick Phillip, public works engineer, Province of British Columbia, Victoria, B.C.

Paper: "Asphaltic Concrete Pavements," by F. L. Fellowes, city engineer, Vancouver, B.C.

Discussion by R. G. Davidson, Warren Bros., Portland, Ore.

Paper: "The Motor Truck; Maximum Weights, Speed, Width, Etc.," by Windsor T. White, chairman, motor truck committee, National Automobile Chamber of Commerce, New York City.

12.30 P.M.—Annual Meeting Canadian Automobile Assn.

Sixth Session.

2.30 P.M.—Presiding Officer: T. J. Mahony, past president, Ontario Good Roads Association, Hamilton, Ont.

Paper: "Provincial Highway Legislation Compared," by F. G. Pearson, past president, Nova Scotia Good Roads Assn., Halifax, N.S.

Paper: "Foundations," by J. A. Duchastel de Montrouge, manager and city engineer, Outremont, P.Q.

Paper: "Surface and Subsoil Drainage," by W. A. McLean, deputy minister of highways, Ontario.

Discussion by A. McGillivray, chairman Manitoba Good Roads Board.

5.30 P.M.—Meeting of newly elected board of directors of the Canadian Good Roads Association, for appointment of committees, etc.

7.30 P.M.—9th annual dinner and entertainment, at Empress Hotel, (informal). Tickets to delegates at special rate of \$1.00.

THURSDAY, JUNE 15.**Seventh Session.**

10.00 A.M.—Presiding Officer, F. A. Gillis, president, Nova Scotia Motor League, Halifax, N.S.

Address by J. B. Harkin, commissioner, Canadian National Parks, Department of Interior, Ottawa, Ont.

Address by J. P. Hartman, Seattle, Wash.

Paper: "Bridges and Culverts," by A. S. McMillan, superintendent of Nova Scotia highways.

Paper: "Road Dragging and Maintenance Competitions," by H. S. Carpenter, deputy minister of highways, Saskatchewan.

Eighth Session.

2.30 P.M.—Presiding officer: H. H. Shaw, chief engineer, department of public works, Prince Edward Island.

Paper by Herbert Cuthbert, executive secretary, Pacific Northwest Tourist Ass'n. "Tourist Traffic."

Discussion by Geo. Webster, Calgary, Alta.

Paper: "How to Finance Road Construction, Bonding and Revenue" by Newell D. Darlington, chairman, California Highways Commission, Sacramento, Cal.

Discussion by Wm. Findlay, Toronto, Ont.

Paper: "Economical Methods of Handling Materials," by Major H. L. Bowby, office of public roads, Washington, D.C.

Paper: "Maintenance," by George Henri, chief engineer, Quebec highways department.

8.15 P.M.—Social Evening and Dance, Empress Hotel.

Most of the people mentioned in the program have already accepted the invitation extended to them, but there may be some changes at the last minute, and the executive have made full provision so that the interesting subjects outlined shall be fully discussed by the convention.

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BUILDING OPERATIONS ON THE INCREASE

RECENT building statistics indicate that not only in this country but also in the United States building operations are very much more extensive than they were for corresponding period last year. Considering the situation on the continent as a whole it is of interest to note that in twenty of the largest cities of the United States the building permits for the month of March were 134% greater than they were for the corresponding month of 1921, and that for 190 cities in the United States the increase over March 1921 was 99%. While perhaps not so remarkable, the increase in Canada has been notable and it might fairly be said that we are in the midst of something approaching a building boom.

An interesting fact concerning this activity is that it largely arises from the building of houses. Whereas, in 1919 and 1920 large numbers of industrial buildings and theatres were constructed, there appears to be little of that class of building now in progress. The country is undoubtedly overbuilt so far as factories and amusement places are concerned and is now catching up in a very legitimate and much needed class of construction.

OPERATION COSTS OF MOTOR BUSES

IN spite of the extensive use of motor buses in America, the published figures of the cost of operation appear to lack consistency and reliability as a basis for estimating probable cost of service in a new locality. An enquiry recently conducted by a committee of the New England Street Railway Club brought out the fact that one reporting company operated at a cost of 28.08 cents per

bus-mile for a 25-passenger bus and the other company answering the questionnaire at a cost of 34.50 cents per bus-mile for a 19-passenger bus. These figures do not include any allowance for dead mileage or for the use or maintenance of the highway. The latter item should, of course, be added to operating costs in any comparison with rail transportation.

Comparison with these figures with those reported by the Massachusetts Public Utilities Commission is of interest. Including taxes and interest on investment at 8%, the cost per bus-mile for a 19-passenger bus was reported by operating companies at 24.26 cents. It was estimated by the commission's engineers that the cost for a 30-passenger bus should be 23.67 cents and for a 51-passenger bus 53.9 cents per bus-mile.

An interesting observation is made by the New England committee to the effect that there are really no reliable data concerning the cost of operation of trolley buses in America. The committee consequently was forced to estimate the probable cost on the basis of experience in Leeds and Tees-side in England. This cost for a trolley bus having a capacity of 25 was estimated at 25.51 cents for New England conditions. The Massachusetts Public Utilities Commission has, on the basis already described, estimated the cost for trolley buses for a 30-passenger bus at 20.59 cents per bus-mile.

The divergence of these figures indicates the impossibility of any prospective user of the motor bus or trolley bus being able to state by analogy with other localities what the probable cost of the operation will be for a new service. The decision of the Toronto Transportation Commission to try out, both the motor bus and the trolley bus under the peculiar conditions existing in Toronto for a sufficient period of time to demonstrate the exact economic characteristics of these services is undoubtedly a piece of sound engineering policy.

STRESSES IN SKEW ARCHES

LITTLE information concerning the distribution of stresses in skew arches has hitherto been available to the designing engineer. It has consequently been assumed by many that the skew arch may be treated in the same manner as the right arch, assuming the span to be the distance face to face of abutments measured parallel to the centre line of the roadway. This is the method outlined by Rankine and many other writers since his time.

Many instances of behavior of skew arches contrary to the assumptions of this theory are now known to the profession. Some twenty years ago a large skew Monier arch collapsed in Australia with loss of life. An investigation conducted by Professor W. C. Kernot, of the University of Melbourne, established beyond doubt that the commonly accepted method of calculating skew arches was seriously in error. Certain recommendations were made by him for thickening up both the arch ring and the abutment at the obtuse angle of the arch, or, what is the same thing, at the acute angle of the abutment. These recommendations were based on the ascertained fact that there was a great concentration of stress along the short diagonal of the horizontal projection of the arch and that the thrust per lineal foot of abutment was much more intense at the acute angle of the abutment than near the obtuse angle.

Recent investigations made by Professor Clyde T. Morris, of the Ohio State University, and described by him in Engineering News-Record substantiate the general conclusions arrived at by Professor Kernot and others. A model skew arch of 4-ft. span and 3-ft. length, skewed at 45 deg. was constructed and tested under various loadings. Both the vertical and horizontal components of the resultant reaction were measured by means of specially devised springs and it was found that these resultant components act very near the obtuse angle of the arch. Indeed, observations showed that there was even indication of a slight uplift at the acute angle.

The investigations of Professor Morris will be welcomed by engineers who have had to design and report upon skew arches with a somewhat unsatisfactory amount of data at their disposal. Appreciation of the actual stresses existing in structures will be greatly facilitated not only by the laboratory experiment mentioned above, but also by the practical observation of stresses in the skew arches of two bridges over the Scioto River in Columbus, Ohio, now being carried out by Professor Morris. While the indication of the tests of models is definite and pronounced, the results of tests on actual structures of full size will carry greater conviction with practicing engineers.

PERSONALS

WILLIAM B. BOYD, the new president of the Dominion Alloy Steel Corp., Ltd., was born in 1871 at Markham, Ont. He attended the Collegiate Institute in Mark-

ham, and afterwards entered the Armour Institute of Technology in Chicago. His first important work was at the World's Columbian Exposition in Chicago. In 1891, where he was placed in charge of the electrical installation of the Art Building, and also of the Administration Building, each building containing 20,000 lights, and after the construction period was appointed chief electrician in charge of lighting and power, approximating 60,000 h.p., by the Westinghouse Electric and Manufacturing Co. of Pittsburg, and remained in this capacity until the close of the

Exposition. He was then appointed electrical and mechanical engineer at the works of the Westinghouse Electrical and Manufacturing Co., Pittsburg, where he remained from 1893 to 1897, obtaining a thorough grounding in his profession through the general courses of training at these works. His next appointment was that of assistant chief electrical engineer of the Illinois Steel Co., Chicago, with an electrical installation of approximately 100,000 h.p. He remained there from 1897 until 1901 in charge of the electrical equipment in all their power stations. In 1901 he was appointed chief electrical engineer of the Dominion Iron and Steel Co., at Sydney, which position he held from 1901 to 1906. In the latter year he became associated with the Toronto Power group headed by Sir William Mackenzie, Sir Henry Pellatt and the late Hon. Frederic Nicholls, and for eight years occupied high positions of trust as consulting and chief engineer in various engineering problems in both construction and operation. He was chief engineer for the Toronto Railway Company; chief engineer for the Electrical Development Co., at Niagara Falls, where he was in full charge of operation of the Niagara Power plant; chief engineer for the Toronto and Niagara Power Co.; and chief engineer for the Toronto Power Co. At present Mr. Boyd is chief electrical engineer of the Toronto and York Radial Railway, and of the Sudbury-Copper Cliff Electric Railway. He is also consulting electrical engineer to the Howard Smith Paper Mills, Ltd., the Maple Leaf Milling Co., and the Ontario Railway and Municipal Board. Between the years 1913 and 1918 he also acted as electrical engineer for the Canadian Northern Railway electrification for the Toronto and Eastern Railway, the Montreal tunnel

and Terminal Co., and the Toronto Suburban Railway. Mr. Boyd is a member of the Electrical Sectional Committee of the Canadian Engineering Standards Association, and also is a member of the Institute of Electrical Engineers of Great Britain.

W. SMITH has been appointed acting city engineer of Brandon, Man.

D. E. KRICK has been appointed road superintendent for Gainsboro Township.

G. A. MCCARTHY, former head of railway and bridges section, has been made head of the sewer section of the city Works Department, Toronto.

THOMAS TAYLOR has been appointed chief of the bridge section of the Works Department, Toronto. Mr. Taylor designed the Bloor Street viaduct in that city.

HERBERT PHILLIPS has been requested by a joint committee of the Halifax City Council and Board of Trade to go to that city and assist in making a check of the valuation of the Nova Scotia Tramways and Power Co.'s physical property as compiled by Jackson & Moreland, of Boston.

OBITUARIES

WILLIAM H. SMITH, builder and contractor, who recently died in Toronto, was born at Scugog Island, Ont., 60 years ago, but had lived in Toronto 40 years.

CHARLES VIRTUE, builder and contractor of Toronto, died in that city on May 17, aged 49. Mr. Virtue was born at Tyrone, Ont., but left to reside in Toronto about 25 years ago.

JOHN HENRY SHAW, widely known in Northern Ontario as the result of many years work as a civil engineer and land surveyor, passed away at North Bay, Ont., on May 12, aged 55. His work included the surveying of a large portion of the mining areas of Cobalt, and even as far north as the Porcupine. Mr. Shaw took a deep interest in the proposed Georgian Bay canal and the French River Improvement scheme.

It is reported that the Dominion Construction Co. of Toronto, has been awarded a contract for the construction of a freight terminal at Niles, Mich., for the Michigan Central Railway. A current authorization of \$500,000 is said to have been made to cover, principally, 320,000 cu. yds. of excavation; the construction of the eastbound hump and eight 100-car receiving tracks; 400,000 cu. yds. of embankment and twelve 100-car tracks of a twenty-five track classification yard, together with a permanent connection with the south end division tracks. It is intended to complete the entire project in 1923.

The province of Quebec, in 1921, laid down 416 miles of good roads, of which 55.5 miles were waterbound macadam, 322.7 miles were gravel, 12.8 miles were bituminous macadam, 12.6 miles were concrete, and 5.6 miles were macadam with cold patch. Over 4,000 miles of good roads are now being kept in thorough repair in Quebec province.

The dates for the annual convention of the American Society of Municipal Improvements which is to be held in Cleveland, Ohio, has been changed by the executive committee, the new dates being October 2-6, 1922. It had been planned to hold the convention from the 9th to 13th of October.

Work on the extension of the Timiskaming and Northern Ontario Railway, northwest from Cochrane, is now well under way. It is planned to complete the proposed 70-mile extension to the T. & N. O. from Cochrane to Tin Can Portage by 1923. Forty-seven miles will be built this year. Next month track laying is to commence. When the whole 70-mile extension is completed, the Ontario government may then consider the advisability of a line to James Bay.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders Close	Issue
North Oxford Tp., Ont., construction of concrete abutments for bridge, also building of grade to bridge....	May 27	May 9
Toronto, Ont., installation of one four-million Imperial gallon centrifugal pump at Island Pumping Station....	June 13	May 9
Dungannon, Ont., construction of overflow drain	May 24	May 9
Ottawa, Ont., various work on Civic Hospital	May 25, 30, June 1	May 9
Waltham, Ont., construction of dam.....	June 1	May 9
Quebec, Province of, macadamizing of Levis-Jackman highway	May 29	May 9
Saskatchewan, Province of, construction of concrete bridges	May 29	May 9
Nassau, New Providence, Bahamas, dredging	July 15	May 9
Edenwold R. M., Sask., road work.....	June 5	May 16
Quebec, Province of, resurfacing of part of Montreal-Ottawa highway	May 30	May 16
St. Catharines, Ont., construction of pavements, etc.	May 25	May 16
Welland, Ont., construction of bituminous penetration road	May 24	May 16
St. Catharines, Ont., construction of sewers	May 25	May 16
Galt, Ont., erection of mill building.....	May 30	May 16
West Luther Tp., Ont., construction of municipal drain	May 27	May 16
Arran Tp., Ont., construction of bridge	May 26	May 16
Caledonia, Ont., construction of two concrete bridges	June 1	May 16
Palmerston, Ont., concrete pavement	May 25	May 16
Quebec, Province of, resurfacing of roads	May 30	May 16
Dixie, Ont., erection of public school building	May 27	May 16
London, Ont., construction of concrete grain tanks and warehouse	May 27	May 16
Moose Jaw, Sask., addition to land titles office	June 1	May 16
Ontario, Province of, construction of a continuation school and alterations to stock judging pavilion at New Liskeard, and erection of school at Monteith	May 27	May 16
Osnaburck & Williamsburg Tps., Ont., construction of drain	June 5	May 16
Ottawa, Ont., masonry, brick and carpentry work, Civic Hospital	May 30	May 16
Stratford, Ont., asphalt paving.....	May 29	May 16
Haldimand County, Ont., concrete bridges	June 1	May 16
Whitchurch Tp., Ont., culverts	May 26	May 16

BRIDGES, ROADS AND STREETS

Alberta, Province of.—Provincial Government intends to complete this year a number of broken pieces of road paralleling the Tofteld, Hardistry and Alsask lines of railway.

Binbrook, Ont.—Tenders will be received by John E. Peart, Clerk, Wentworth County, Hamilton, until 12 o'clock noon, May 20, for the construction of approximately 9,500 sq. yds. of concrete pavement, to commence at the village of Binbrook. Plans and specifications may be seen on application at the office of the County Clerk, Court House, Hamilton.

Blenheim Tp., Ont.—Contract for abutments and steel bridge over Smith's Creek has been awarded to the Stratford Bridge and Iron Works Co., Stratford.

Brant Tp., Ont.—Tenders will be received until noon, Friday, June 2, for steel bridge and abutments. (See official adv.).

Brantford, Ont.—City Council intends to construct asphalt pavements on Chatham Ct., Church St., Colborne St., George St., Nelson St., Palmerston Ave. and Wellington St., at a total estimated cost of \$64,540.15. City Clerk, H. F. Leonard.

Bridgeburg, Ont.—The Canadian Niagara Boulevard Commission has promised definitely to extend the highway the extra five miles from Queenston to Niagara.

British Columbia, Province of.—Contract for the construction of the first nine miles of the Nelson-Ymir highway, south from Nelson, has been let to DeWolf & Ham, of Cranbrook, at \$79,029.07.

Chatham, Ont.—Tenders will be received by L. A. Pardo, Road Superintendent of Kent County, until noon, Saturday, May 27, for the construction of three concrete and steel bridges, one of 34 ft. span, one of 12 ft. and one of 4 ft. span. Plans and specifications may be seen at office of W. G. McGeorge, C.E., Chatham.

Chatham, Ont.—Tenders will be received by L. A. Arthur, Clerk, Chatham Township, until noon, Saturday, May 27, for the construction of four concrete and steel bridges, one bridge of 40-ft. span and the others of 50-ft. spans. Plans and specifications may be seen at office of W. G. McGeorge, C.E., Chatham.

Chatham, Ont.—Contract awarded to S. P. West, of Sandwich, at \$1.90 per sq. yd. for concrete, and 72c per sq. yd. for excavating sub-grade, for paving within the sub-area of Kent County at Chatham. Other tenders received were: Johnson Bros., \$2.44 and 65c; Cadwell Construction Co., \$2.17 and 60c; Merlo, Merlo & Ray, \$2.40 and 70c; McNamara Bros., \$2.92 and 90c; Geo. H. Connebear, \$3.25 and 80c; W. J. Looby, \$2.43 and 65c; J. E. Caughey, \$2.78 and 79c; Geo. Cutter Co., \$3.05 and 76c; and Lumsden Eng. & Trans. Co., \$2.94 and 65c.

Chatham, Ont.—Tenders received for the construction of concrete base and curb on Lowe, Wilson, Cornhill, Ursuline and Adelaide Sts. were not considered satisfactory by the City Council and were referred back to the committee for report. Tenders were as follows: George Connibear, concrete base, 70c, curb, 20c; G. Fielder, Lowe St. base, 69c; Wilson base, 69c, Cornhill, 71c; Ursuline, 72c; Adelaide, 75c; curb on all streets, 18c. If given all the work, base 68c and curb 17c. Board of Works Department's prices were: Curbs on all streets mentioned, 18c; base Lowe St., 60c; Wilson, 62c; Cornhill, 60c; Ursuline, 62c; Adelaide, 60c.

Chatham, Ont.—Following contracts let for construction of concrete pavements in Kent County: To Merlo, Merlo & Ray, Walkerville, for 1½ miles near Thamesville, at \$2.63 per sq. yd. for paving and 60c for sub-grade. Other tenders received: Lumsden Contracting Co., \$2.93 and 65c; J. E. Caughey, \$2.88 and 60c; McNamara Bros. & Thornton, \$3.12 and 60c; G. W. Cutter Co., \$2.99 and 50c. For 5½ miles between Wallaceburg and Dresden, J. E. Caughey, Wallaceburg, at \$2.16 per sq. yd. for paving and 60c for sub-grade. Other tenders received: Merlo, Merlo & Ray, \$2.25 and 60c; G. W. Cutter Co. \$3.06 and 50c; Cadwell Sand & Gravel Co., \$2.27 and 60c; McNamara Bros. and Thornton, \$3.03 and 60c; S. P. West, \$2.10 and 65c. Above prices are all on basis of contract of supplying all material.

Cloverdale, B.C.—Contract for clearing, grubbing, grading and gravelling about 1,000 ft. of the Bjornson road from the Semlahmoo trail south has been awarded to Carmack & Tillotson. Work has started.

Cornwall, Ont.—Approximately \$50,000 will be expended by the United Counties of Stormount, Dundas and Glengarry on road work, contracts for which have been awarded to F. M. Eagleson, of Winchester; S. Gauthier, Moose Creek; Mr. McCallum, Apple Hill; and Neil McDonald, Alexandria.

Cornwall, Ont.—Tenders will be received until one o'clock, p.m., Thursday, May 25, for the construction of 1,000 cu. yds. of waterbound macadam in Williamsburg Township for the United Counties of Stormount, Dundas and Glengarry. Plans and specifications may be seen at the office of J. G. Cameron, County Road Supt., County Bldgs., Cornwall, Ont.

Dresden, Ont.—Contract awarded by Town Council for construction of pavements to the Cadwell Sand & Gravel Co. Other tenders received were: J. E. Caughey, Geo. W. Cutter Co., Johnson Bros. Co., Ltd., Merlo, Merlo & Ray, Ltd., Hamilton Contract Co., Ltd., and McNamara Bros. & Thornton.

East Zorra Tp., Ont.—Township Council passed by-law authorizing expenditure of \$12,000 on township roads. Clerk, Edwin Parker, Tavistock.

Fenelon Falls, Ont.—Council plans to pave Lindsay and Colborne Streets complete. Clerk, E. Fitzgerald.

Ford City, Ont.—Contract let by Town Council to Merlo, Merlo & Ray for repairing pavement on Sandwich St.

Ford City, Ont.—Town Council let contract for silex walks to the Cadwell Sand & Gravel Co., Ltd., at \$7,434.70. Other tenders received: Oakwood Construction Co., \$8,531; L. J. Ryan, \$7,988; Geo. S. Currie, \$7,811; B. Oldani & Co., \$8,723.80; Premier Construction Co., \$7,663; Coloutie Bros., \$7,615.40.

Galt, Ont.—City Council intends to construct an asphaltic concrete pavement on the north side of Main St., from Elgin St. to City Limits, at a cost of \$3,300. City Clerk, Joseph McCartney.

Hamilton, Ont.—Tenders will be received by John E. Peart, Clerk, Wentworth County, Court House, until 12 o'clock noon, May 30, for the construction of approximately 9,500 sq. yds. of concrete pavement to commence at the village of Binbrook, County of Wentworth. Plans and specifications may be seen on application at the office of the County Clerk, Court House, Hamilton.

Hamilton, Ont.—Hon. F. C. Biggs, Minister of Public works and Highways for Ontario, has announced the following road building program to be carried out in Wentworth County this year: Main Street road from city limits to fork of King & Main, just below Stoney Creek, concrete (contract let); Main Street road from the fork to Winona P.O., five miles, asphalt concrete; Hamilton-Brantford road, unfinished portion between Ancaster Village and the county line, asphaltic concrete (under contract); foundation work on the Hamilton-Galt road in Wentworth County to be finished this year; three miles of surfacing from Clappison's Corners to Black's Corners; foundation work on the Dundas Road, from Clappison's Corners through Waterdown to the county line, finish the foundation work on the Hamilton end of the Toronto-Hamilton Highway, the road expected to be open by July 1; three miles of foundation work

on the Caledonia road further south than the three miles completed last year. Mr. Biggs estimated that when completed, Wentworth County will have 62 miles of provincial highway at an average cost of \$25,000 a mile, or a total cost of \$1,550,000.

Hull, Que.—City Council will send a delegation to request the Minister of Public Works to have approach to Chaudiere Bridge repaired.

Humberstone Tp., Ont.—Township Council plans an expenditure of \$15,050 on township roads this year. Clerk, A. E. Near, Port Colborne, Ont.

Kenilworth, Ont.—Contracts for three small concrete bridges for Arthur Township were let to John Ashwood, of Kenilworth, for \$8.40 per cu. yd. Quite a number of tenders were received, running from \$8.40 to \$13 per cu. yd.

Kirkland Lake, Ont.—A plan is under way to petition the Ontario Government to extend the Kirkland Lake Highway another six miles so as to connect up with that part of the old road from Dane Station to the Argonaut mine at Beaverhouse Lake.

Kitchener, Ont.—The following streets will be paved this summer: Union, from King to Herbert; John, from King to Willow; Allan, from King to Willow; Mary, from Union to Allan; Willow, from Allan to Erb; Erb, from Willow to Peppier; and Victoria, from Erb to Weber Streets. City Engineer, S. Shupe.

Knowlton, Que.—Tenders addressed to J. E. Fay, Sec.-Treas., Municipality of the County of Brome, Knowlton, Que., until 10 o'clock a.m., May 27, for the construction of an iron or metallic bridge with concrete piers, and the approaches of said bridge, between the local municipalities of the Townships of Brome and Sutton. Plans and specifications may be seen at office of Secretary-Treasurer.

Lachine, Que.—Provincial Government will finance the construction of the Summerlea roadway in this municipality.

Lambeth, Ont.—Surveyors are now engaged in laying out the extension of the Lambeth highway beyond this village to Talbotville, from which point the contract has already been let for a section of paved road leading into St. Thomas. It is also understood that the Crumlin road will be paved this year, from the city limits to three miles east.

Lindsay, Ont.—Colborne St. will be paved this summer with asphaltic concrete by the Standard Paving Co.

London, Ont.—City Council considering the paving of Wharncliffe Road North this year. City Engineer H. A. Brazier.

London, Ont.—A movement is now under way to have Queen's Ave. widened 10 ft. between Richmond and Waterloo Sts. City Engineer, H. A. Brazier.

London, Ont.—Tenders will be received by John M. Moore & Co., Architects, London, until noon, Wednesday, May 31, for the construction of a steel and reinforced concrete bridge over the north branch of the River Thames, London. Plans and specifications may be seen at the office of the architects, or at the office of R. E. W. Hagarty, Consulting Engineer, Temple Building, Toronto.

Lucan, Ont.—Village Council decided to pave Main St. Clerk, Walter L. Gibson.

Manitoba, Province of.—Tenders are being called by the Provincial Government for the stumping and grubbing of five miles of the Keewatin-Manitoba boundary road, from mileage two to mileage seven. It is expected that grading of the road will be proceeded with as soon as this stumping and clearing is done. Plans and specifications of this work are in the offices of the Northern Development Branch at Kenora and Dryden.

Mimico, Ont.—Tenders for the construction of a large number of pavements are to be called shortly. Town Clerk, J. A. Teller.

Montreal, Que.—Executive Committee of City Council decided to re-floor the Vian bridge at an estimated cost of \$1,000, city to do work by day labor.

Montreal, Que.—Executive Committee recommended to City Council that William McNally & Co. be awarded a contract for supply of 100,000 granite blocks at \$112

per 1,000 blocks. Two other bids were received for \$118 and \$120, respectively.

Montreal, Que.—The repavement of Wellington St., from McGill to the limits of Verdun, at an estimated cost of \$250,000, is one of the important street improvements to be undertaken by the Executive Committee of the City Council this year. Granite blocks will be used from McGill to Bridge St., and from Bridge St. to the tail race, the paving material will be asphalt.

Montreal, Que.—Tenders addressed to the Executive Committee for the construction of concrete sidewalks on Boyer St., Bordeaux St., Ash St., Kelly St., Labrecque St., St. Lawrence Boulevard and St. Joseph Boulevard, will be received at the City Hall until May 26. Specifications may be obtained at the office of the Roads' Branch, Department of Public Works, City Hall.

Nelson, B.C.—Tenders closed May 20 for construction of approximately three miles of city streets. City Clerk, W. E. Wasson.

Niagara Falls, Ont.—Engineers of the Michigan Central Railway are here discussing plans for the proposed bridge to displace the present cantilever bridge.

Niagara Falls, Ont.—Plans submitted show that great changes will be made in the bridges here. A complete new structure will be built between the present cantilever bridge and the one used by the Grand Trunk and for pedestrian traffic. The contract for the latter calls for its completion within two years. The lower bridge will be greatly extended. At present there are two tracks on the upper decks, and vehicle and foot roadway on the lower deck. By the improvements projected the bridge will be widened to one hundred feet in width. The upper deck will carry four railroad tracks. The lower deck will carry a double track trolley line through the centre portion. On either side of these will be a wide roadway for automobile or other vehicular traffic. Entirely outside the bridge structure on the sides of the lower deck will be sidewalks for foot traffic.

Normandy Tp., Ont.—Tenders addressed to R. H. Fortune, Township Clerk, Ayrton, Ont., until 6 p.m., Friday, May 26, for the construction of three girder bridges. Plans and specifications may be seen at the office of the Township Clerk or R. McDowall, Township Engineer, Owen Sound.

Ontario, Province of.—George Hart, of Picton, has been awarded the contract for building the Provincial highway between Union Hill and Belleville.

Ontario, Province of.—Somerville & Dilworth have started work on a Provincial road contract from St. David's Hill to Niagara Falls, a distance of about 2½ miles. Concrete construction.

Ontario, Province of.—Hon. F. C. Biggs, Minister of Public Works and Highways, stated that \$1,500,000 will be spent in the Hamilton district on good roads this year. This will include cost of foundation of Galt-Hamilton road.

Ontario, Province of.—Hon. F. C. Biggs, Minister of Public Works and Highways, promised a deputation which called on him recently on behalf of the North Yonge Street Highway Improvement Association, that he would send an official from his department to report on the possibility of the scheme the deputation had presented to him. This scheme is a plan for widening Yonge St. to 100 feet from the city limits to Mulock's Corners, north of Aurora.

Oshawa, Ont.—By-law will be submitted to ratepayers on June 10 authorizing the purchase of a 1,000-gallon street flusher at a cost of \$7,900.

Oshawa, Ont.—Town Council adopted an extensive program of new pavements and sidewalks for this year, and instructed Town Engineer W. C. Smith to prepare plans and specifications for concrete and asphalt and advertise for tenders for laying same.

Oshawa, Ont.—Board of Works recommended to Town Council the paving of Albert St. to the C.P.R. bridge; Ritson Road, from King St. to Olive Ave.; and Avenue St., from Simcoe to Centre. Tenders will be invited for concrete and bitulithic.

Ottawa, Ont.—Final reading was given in the House of Commons to the bill of the Canadian Translt Co. which

is to build an international bridge between Windsor and Detroit. The bill now goes to the Senate.

Ottawa, Ont.—Tenders will be received by T. H. Byrne, Engineer, Carleton County, Ottawa, until 12 o'clock noon, Friday, May 26, for the construction of (a) bituminous penetration on Richmond Road, township of Nepean; (b) bituminous penetration in village of Carp, township of Huntley; (c) bituminous penetration in village of Osgoode, township of Osgoode; and (d) waterbound macadam on Base Line Road and Cyrille Road, township of Gloucester. Plans and specifications may be seen at office of Patterson & Byrne, 71½ Sparks St., Ottawa.

Ottawa, Ont.—The bill to incorporate the Buffalo and Fort Erie Public Bridge Co. with a capital of \$1,500,000 was reported by the House Committee on Private Bills recently. The bill provides for the construction of a bridge across the Niagara River between the village of Fort Erie, Ont., and Buffalo, N.Y., and is to be built as a private undertaking with the consent and supervision of the Governments of Canada and the United States. It is proposed to charge tolls on the bridge, and when these tolls have met the construction and interest charges to hand the structure over to the two Governments.

P.E.I., Province of.—Department of Public Works awarded contracts as follows for highway improvement work: Project No. 24, Alfred Cameron, South Melville, P.E.I., and George McLean, North Wiltshire, P.E.I.; project No. 25, Duncan McKenzie, French River, P.E.I., and Edward Stewart, French River, P.E.I.; project No. 26, Henry J. Phillips, Charlottetown, P.E.I., and P. G. Clark, Summerside, P.E.I.; project No. 27, Duncan McKenzie, French River, and Edward Stewart, French River; project No. 28, Duncan McKenzie, French River, and Edward Stewart, French River; project No. 30, H. M. Downing, Summerside, P.E.I.; project No. 31, H. M. Downing.

Peterboro, Ont.—Contract for completion of Provincial highway between Peterboro and Port Hope has been let to Cameron Bros. & Hutt, of Cornwall.

Peterboro, Ont.—City Council intends to construct a sidewalk on Weller St., south side, from Monaghan road to Albertus Ave., and on the south side of Wolseley St., from Benson St.

Peterboro, Ont.—City Engineer R. H. Parsons will report to Board of Works on construction of a sidewalk on the west side of Donro Armour Road, from Clifton St. to Douro St.

Pikington Tp., Ont.—Tenders will be received until 10 a.m., Friday, May 26, by George F. Cromar, Township Clerk, Elora, Ont., for the construction of a 36-ft. bridge and abutment for steel bridge. For plans and specifications apply to Township Clerk or A. W. Connor, Engineer, 34 Victoria St., Toronto.

Port Stanley, Ont.—Elgin County Council will repair the bridge. Federal Department of Public Works will be urged to construct a new bridge next year. County Engineer, James A. Bell, St. Thomas.

Quebec, Province of.—Some \$7,000,000 are to be spent in the next two years for construction, repairs and maintenance of roads in this province.

Quebec, Province of.—Tenders for the Quebec-St. Anne Highway are to be called for at once. Specifications call for macadam construction.

Quebec, Province of.—The advisability of building a bridge on the Saguenay River, at Chicoutimi, is being discussed by the Provincial Government and estimates for next Session of the Legislature are being prepared.

Quebec, Que.—Tenders will be called for the repairing and paving of certain streets in each ward. The Provincial Legislature has authorized the city to expend \$264,000 on such work, but the lists of streets to be repaired prepared by the aldermen call for an expenditure of about \$1,000,000.

Quebec, Province of.—Tenders, addressed to Amedee Dorion, Sec.-Treas., Municipality of Quebec County, until May 23, for the construction of a bridge spanning the Beauport River, and approaches of said bridge. Plans and specifications may be seen at the Department of Public Works, Quebec.

Quebec, Province of.—The good roads program of Hon. J. L. Perron, Minister of Roads, has been announced and calls for an expenditure this year of \$7,500,000. The general plan, taking Montreal as the centre, is that the highways of the Province shall stretch out to Hull, to Mont Laurier, to Lacolle, to Malone, to Sherbrooke, to Quebec and, with Levis as another centre, is the road to Jackman, Maine, the road to Sherbrooke and then to Derby Line, Vermont. Below Quebec is the long road to Rimouski and the road from Riviere du Loup to Edmundston, N. B. The money will be appropriated as follows: Regional roads, \$3,450,000; municipal works, \$2,100,000; rebuilding and upkeep, \$1,450,000; special work and administration, \$500,000.

Rovelstoke, B.C.—Tenders for bridge over Columbia River will be received by the Hon. the Minister of Public Works, Victoria, until 12 o'clock noon, Monday, June 19. (See official adv.).

Riverside, Ont.—Contract let by Town Council to Coltatti Bros. for construction of sidewalk on Lauzon Road and on the east side of St. Louis Ave.

Riverside, Ont.—Tenders were received until May 17 for construction of 1,584 ft. 3-in. wide concrete sidewalk on Lauzon Road, from Hydro R. R. South, and 1,100 ft. 4-in. concrete sidewalk on St. Louis Ave. Clerk, C. J. McHugh, Box 304, Ford, Ont.

Riviere du Loup, Que.—Ratepayers passed by-law authorizing the borrowing of \$200,000 for paving work. Work will start at once.

St. John, N.B.—Tenders for supply to Public Works Department of 1,075 lin. ft. of straight and 144 ft. circular curbing were opened by Common Council as follows, at rates per lin. ft.: Granite Street Paving and Construction Co., \$1.75 for straight, \$2.00 for circular; B. Mooney & Sons, Ltd., \$1.55 for straight, \$1.65 for circular. Referred to commissioner of works and road engineer.

St. Lambert, Que.—Following tenders were received for paving Riverside Drive; Warren Bituminous Paving Co. of Ontario, Ltd., Toronto, bitulithic pavement, at \$3.58 per yd.; Bernard Brault, Ltd., Montreal, asphaltic concrete, \$2.60 and sheet asphalt, \$3.94; Sicily Asphaltum Paving Co., Montreal, asphaltic concrete, \$3.74 and sheet asphalt, \$4.14; Quinlan Robertson & Janin, Montreal, asphaltic concrete, \$3.80, sheet asphalt, \$4.19 and bitulithic, \$4.05; Wm. I. Bishop Co., Montreal, asphaltic concrete, \$3.83 and sheet asphalt, \$4.52. Tender of Warren Bituminous Paving Co. was accepted, the total amount of the contract price being \$50,120.

Saanich, B.C.—Council accepted offer of Douglas, MacKay & Co., agents for the British Columbia Refinery Co., of Port Moody, to supply heavy road oil at 10½¢ per gallon. Council decided to construct a sidewalk in front of St. Jude's Anglican Church, on Obed and Dysart Roads.

Simcoe, Ont.—After opening tenders for concrete and Tarvia macadam roadway on the Provincial county road leading north from Simcoe, the Norfolk County Council decided to continue Tarvia macadam construction by day labor under the county road committee and County Engineer Guy R. Marston.

Simcoe, Ont.—North Townsend wants Norfolk County to take over two and a fourth miles more of their road. The residents about Port Ryerse, westerly, want an extension southward from the Vittoria turn and a new road and bridge built to cut the detour down towards Port Ryerse—a \$100,000 proposition possibly.

Stratford, Ont.—City Council intends to construct following works: (1) Excavation, concrete base, concrete combined curbs and gutters, drainage and bituminous surface, 19.3 ft. wide on Front St., extending from the North boundary of East Gore to the North boundary of Perth St., at an estimated cost of \$3,568; (2) excavation, concrete base, concrete combined curbs and gutters, drainage and bituminous surface, 19.3 ft. wide on Grant St., extending from West boundary of Downie St. to the East boundary of Home St., \$7,278; and (3) excavation, concrete base, concrete combined curbs and gutters, drainage and bituminous surface, 19.3 ft. wide on Home St., extending from South

boundary of West Gore St. to the South boundary of Grant St., \$4,429. City Clerk, W. H. Dorland.

Sydney, N.S.—Plans and specifications for the new Argyle Street bridge have been completed by the city engineer and will be submitted to council, after which tenders will likely be called.

Talbotville, Ont.—Contract awarded by the Provincial Highway Department to F. D. Milligan, of Slonx Lookout, Ont., for the grading of eighteen miles of Provincial highway from Talbotville westward.

Tilbury, Ont.—Town Council has engaged Frank Barber & Associates, Ltd., Consulting Engineers, 40 Jarvis St., Toronto, to prepare plans and specifications for and oversee the construction work of paving Young St., Market Lane and Caryle Ave., and portions of Prospect and Superior Streets.

Tilbury, East Tp., Ont.—Contract for erection of two 30-ft. concrete bridges over the McDougall drain was awarded to J. G. Gleeson, of Fletcher, Ont., at \$1,645 for each bridge, contractor to supply all materials. Other tenders received were: Chas. Hubbell, \$2,400 each; John Tewkesbury & Son, \$1,987.50; Napoleon Giroux, \$2,835; C. E. Hope, \$1,850; Canadian Des Moines Steel Co., \$1,850; Jos. Rivait, \$2,250.

Toronto, Ont.—City Council plans to widen Geary Ave.

Toronto, Ont.—City Council referred back Jane St. widening until promulgated line legislation is passed. Estimated cost, \$80,000.

Toronto, Ont.—Only one tender has been received by the Board of Control for the construction of the new Gerard St. bridge, which is estimated to cost \$750,000.

Toronto, Ont.—Board of Control recommended that the proposed widening of Jane St. at a cost of \$20,000 be struck out pending the action of the Legislature on the deferred street widening bill.

Toronto, Ont.—Civic Works Committee instructed Works Commissioner Harris to prepare a new recommendation and estimate of cost of widening Bloor St. to 86 ft., between Sherbourne St. and Spadina Ave.

Toronto, Ont.—There is a possibility that upper Yonge St. will be widened to 86 feet between Shaftesbury Ave. and Heath St., so as to make that thoroughfare of uniform width from the C. P. R. station to the northern city limits.

Toronto, Ont.—Time for receiving tenders for the removal of the existing bridge over the Don River on Gerrard St., and the construction of a new three-span steel arch bridge, with concrete floors, abutments, retaining walls and floors, together with earthfilled approaches to same, has been extended until 12 o'clock noon, Tuesday, May 30. Specifications may be obtained upon application to Room 313, Department of Works, City Hall.

Victoria, B.C.—Ratepayers passed bylaw providing for borrowing of \$110,000 to complete Johnson Street bridge.

Walkerville, Ont.—Board of Works will take up the matter of the construction of sidewalks through Willstead Park.

Walkerville, Ont.—Definite action in reconstructing the Walkerville bridge on Sandwich St. has been promised at an early date to the Town Council by Hon. W. C. Kennedy, Minister of Railways.

Waterloo, Ont.—Tenders are being called by the Town Council for the paving of eight streets. Clerk, James C. Haight.

Welland, Ont.—Tenders will be received by Robert Cooper, Clerk, Welland County, until June 5, for the construction of 9-ft. waterbound macadam road in Township of Pelham; 16-ft. waterbound macadam road in Township of Wainfleet; for oil, asphalt, Tarvia or any other preservative of waterbound macadam roads; and for treating macadam road with above-mentioned preservative. Plans and specifications may be seen at County Clerk's office, Welland.

Westminster Junction, B.C.—Tenders will be received until 12 o'clock noon, Saturday, June 10, for the construction of a steel highway bridge over the Coquitlam River, as follows: (a) For the manufacture and delivery f. o. b. on cars at Westminster Junction, C. P. Railway, of one 200-ft. through steel highway bridge span; (b) for the acceptance, erection and painting of the above, complete

with floor system, etc.; (c) for the erection and completion of the sub-structure. Plans and specifications may be seen at the office of the Government Agent, Vancouver; District Engineer, New Westminster; and the Department of Public Works, Victoria.

Weston, Ont.—Weston road business men approved Weston road widening.

Whittemouth, R. M., Man.—Rural Municipal Council proposes to pass a by-law for the opening and construction of a roadway. Sec.-Treas., Charles Pound.

Windsor, Ont.—Public Works Committee recommended acceptance of tender of Cadwell Construction Co. for paving Ouellette Ave., from Wyandotte St. to Anne St.

Windsor, Ont.—City Council intends to construct a concrete pavement on the alley between Ouellette St. and Cartier Place, from London St. to the alley north of Park St. to Cartier Place, at a cost of \$3,515.

Windsor, Ont.—City Council intends to construct a sheet asphalt pavement upon a concrete foundation on Wyandotte St., from Gleggarry Ave. to the easterly City Limits, at an estimated cost of \$135,937. City Clerk, M. A. Dickinson.

Windsor, Ont.—Public Works Committee authorized an appropriation of over \$200,000 for widening Pellissier, Chatham and Park Streets. Ouellette, from London St. to Ann St., also will be widened and repaved. Petitions are being circulated by property-owners between Anne and Erie Streets, on Ouellette, for a similar improvement in that neighborhood. City Engineer, M. E. Brian.

Winnipeg, Man.—Tenders closed May 16 for the construction of a number of granolithic walks. City Clerk C. J. Brown.

Winnipeg, Man.—Contracts for construction of granolithic walks on McGee and Craig Sts. awarded to City Engineer W. P. Brereton for \$3,011.40.

York Tp., Ont.—Township Council decided to widen Weston Road to 70 ft., from the southern boundary of Weston to the north side of Black Creek Hill. Engineer, Frank Barber, 40 Jarvis St., Toronto.

York Tp., Ont.—Following contracts awarded by Township Council: Construction of concrete sidewalks on Caledonia Ave. and Strathearn Road to A. Johnson; concrete sidewalks on Hertford Ave. and Dundurn Ave., National Cont. Co.; grading of Greenwood and LeRoy Avenues, C. Matthews.

WATER, SEWAGE AND REFUSE

Edmonton, Alta.—Supt. W. J. Turner, of the city water works department, announced that plans for a sewer extension to the Highlands and water services for Bellevue and the Bellevue addition are being prepared. Estimated cost, \$80,000.

Fredericton, N. B.—Tenders for the excavation of trench and laying water pipe on Woodstock Road, from Smythe St. to Hermitage Bridge; on Campbell St., between Phoenix Square and Westmorland St., continuing to Queen St.; Aberdeen St., between St. John and Carleton Streets extended; Victoria St., between Westmorland and York Streets; Westmorland, between Charlotte St. and Aberdeen St.; Saunders St., between Westmorland and York; York St., from Aberdeen St. and C. P. R. tracks; and York St., from Argyle to Victoria St., will be received at the office of the City Clerk, City Hall, until 12 o'clock a.m., Tuesday, May 30, City Engineer, G. C. McDowell.

Guelph, Ont.—Public Works Committee instructed City Engineer F. McArthur to have plans prepared by him for construction of sewer from Gordon St. to the disposal plant approved by Provincial Board of Health and work proceeded with at once. Estimated cost, \$59,420.

Hamilton, Ont.—City Council passed by-laws providing for the raising of \$258,710 for the construction and extension of water mains, and \$104,780 for extending and improving the Hamilton water works.

Kitchener, Ont.—Local Board of Health is urging the City Council to proceed with the construction of proper

sewerage connections in the northeast end of the city, east of Lancaster St., and particularly in the vicinity of Guelph St.

New Toronto, Ont.—By-law providing for the raising of \$12,000 for the construction of the new water intake was passed by Public Utilities Commission and will be submitted to ratepayers.

Niagara Falls, Ont.—Water Commissioners authorized installation of water services on Victoria Ave., between Palmer and Delaware Aves. Also the construction of a 6-in. water main on West Simcoe St.

Peterboro, Ont.—Utilities Commission will construct \$3,000 on improvements at the filtration plant.

Peterboro, Ont.—Utilities Commission will construct an 8-in. main on Bethune St. Superintendent, R. L. Dobbin.

Peterboro, Ont.—City Council authorized the borrowing of \$250,000 for local improvements and the purchase of sewage disposal plant property.

Peterboro, Ont.—City Engineer R. H. Parsons reported to the Board of Works on the cost of a sewer to serve the Engleburn Ave. district at \$8,391.

Peterboro, Ont.—A request to the Board of Works for the extension of the sewer on Lake St. was referred to City Engineer R. H. Parsons for a report. Mr. Parsons will also report on the construction of a sewer on Wolseley St.

Riverside, Ont.—Town Council awarded contract to Collatti Bros. for water mains from Eau Claire Water works to Little River, on John M. Elinor and Fairview Avenues.

Riverside, Ont.—Tenders were received until May 17 for construction of 360 ft. of 6-in. and 1,150 ft. of 4-in. cast iron water main on Clair View, Elinor and John M. Streets, and 1,750 ft. 6-in. cast iron water main from Eau Claire Water plant to Little River. Clerk, C. J. McHugh, Box 304, Ford, Ont.

St. John, N.B.—Authority for a call for tenders for excavating and backfilling for watermain renewals, estimated to cost \$69,900 was granted in committee of the Common Council.

St. Thomas, Ont.—A sewer is to be constructed in Malakoff St. City Engineer, W. C. Miller.

St. Thomas, Ont.—In connection with the proposed extension of water service to Yarmouth Heights, the St. Thomas Water Commission has suggested that the property owners in Yarmouth Heights organize the community into a police village and install their own mains and distributing system to Fifth Ave. and Wellington St., the commission to supply the water.

Saanich, B.C.—By-law providing for an ultimate issue of \$750,000, of which \$270,000 will be raised immediately to inaugurate a sewerage system in the municipality will shortly be submitted to the ratepayers. Clerk, H. S. Cowper.

Saskatchewan, Province of.—Tenders will be received until 12 o'clock noon, Wednesday, May 31, for constructing an earth road from Wroxton west 8 miles. Plans and specifications may be seen at office of H. S. Carpenter, Deputy Minister of Highways, Regina, and at the offices of the following: Wm. Grant, 810 Canada Building, Saskatoon; J. R. Reid, Court House, Swift Current; F. G. Kissack, Dominion Grain Co., North Battleford; and Wm. H. Hoar, Sec.-Treas., R. M. No. 241, Calder, Sask.

Saskatchewan, Province of.—Tenders will be received until 12 o'clock noon, Wednesday, May 31, for constructing an earth road from Esterhazy to Stockholm. Plans and specifications may be seen at the office of H. S. Carpenter, Deputy Minister of Highways, Regina, and at the offices of the following: Wm. Grant, 810 Canada Building, Saskatoon; J. R. Reid, Court House, Swift Current; F. G. Kissack, Dominion Grain Co., North Battleford; and H. Munchy, Sec.-Treas., R. M. No. 183, Stockholm, Sask.

Sault Ste. Marie, Ont.—Contract for construction of 740 lin. ft. 15-in., 214 lin. ft. 12-in., 1,464 lin. ft. 10-in. and 7,509 lin. ft. 8-in. the pipe sewer awarded to Donato, Salerno & DeLuca, at \$17,981.18. Other tenders received were: Bombacco Bros., \$20,166.89; McNamara Bros., \$19,-

398; Ceasar Acciaviatti, \$21,600; and Bernardi & Disano, \$21,549.27. Contract for construction of 218 lin. ft. 42-in., 822 lin. ft. 36-in. and 172 lin. ft. 30-in. reinforced concrete sewer pipe awarded to L. Nonne, at \$9,744.05. Other tenders received: Bombacco Bros., \$12,922.95; Toni De Pietro, \$13,040.75; McNamara Bros., \$9,945; Ceasar Acciaviatti, \$13,559.90; Bernardi & Disano, \$11,530; Taylor & Hughes, \$12,742.40. Contract for construction of 265 lin. ft. 18-in. reinforced concrete pipe, 450 lin. ft. 10-in. tile pipe and 120 lin. ft. 8-in. tile pipe, awarded to L. Nonne, at \$2,196.35. Other tenders received: McNamara Bros., \$3,350; Ceasar Acciaviatti, \$3,233.27.

Scarboro Tp., Ont.—Commissioners of Scarboro Public Utilities, under the chairmanship of E. M. Croker, Reeve, are desirous of opening up a new water area, comprising the districts of Scarboro Bluffs, Scarboro Junction and Kitchener Park, to Stop 28 on the Kingston Road. The Township of York is also negotiating with Scarboro for water supply.

Toronto, Ont.—Contract for construction of sewer on Ardagh St., from Durie St. to Jane St., has been awarded to the Grant Contracting Co., at \$3,390.

Toronto, Ont.—Board of Control approved for paving of Annette St., from Runnymede to Jane St. Runnymede Road pavement, from Annette to Dundas, was also approved.

Toronto, Ont.—Street Commissioner Wilson recommended another new site for the municipal incinerator, in the neighborhood of St. Clarens Ave. and the C. P. R. tracks in West Toronto. This would make an incinerator in the Earlscourt district unnecessary he claimed. Works Committee decided to view the proposed sites.

Toronto, Ont.—Tenders will be received, addressed to C. Alfred Maguire (Mayor), Chairman, Board of Control, until noon, Tuesday, June 6, for the laying and jointing of 6-in. water pipes in the following streets: Alberta Ave., Brunswick Ave., Evans Ave., Fairlawn Ave., Forman Ave., Glenmount Park Road, Rose Park Crescent and Runnymede Road. Specifications may be obtained upon application at Room No. 3220, City Hall.

Toronto, Ont.—Contracts for laying and jointing 6-in. water pipes awarded as follows: To Ruscia Bros. Co., Claude Ave., Glendale Ave., Merrick Ave., Patterson Ave., Simpson Ave., Lighthouse Ave. and Engham Ave., for a total of \$1,698.38; W. E. Taylor, Elmer Ave., Garfield Ave., Haslett Ave., Rhyll Ave. and Mount Pleasant Road, \$1,523.87; Grant Contracting Co., Ltd., St. Germain Ave., \$573.

Vancouver, B.C.—Vancouver and District Joint Sewerage Board has authorized a \$600,000 bond issue to finance the work for the balance of the year.

Vancouver, B.C.—City Engineer Fellowes has prepared a list of streets which are to be improved this year, provided it meets the approval of the Civic Board of Works, including the paving of streets in the Kitsilano, Fairview, Grandview, Hastings Townsite and D. L. 301 districts. The leading thoroughfares on which work is planned, include the paving of Broadway, from Trafalgar to Alma Road, a distance of about 5,000 ft.; paving of Hastings St. East, from Renfrew St. to the boundary, 5,000 ft.; Commercial Drive, from Twelfth to Fifteenth Avenues, 960 ft.; from Kingsway to Twenty-fifth Ave., 2,880 ft.

West St. Paul, R. M., Man.—Contract for drilling two wells on Rossmore Ave. has been awarded to E. J. Hoffman, 59 Royer Ave., Winnipeg. Tenders were also received from the following: Wm. Falconer, 425 College Ave., Winnipeg; C. H. Snelair, Selkirk, Man.; Ambrose Pruden, Lbhu, Man.; Thomas Stokes, 242 Magnus Ave., Winnipeg; J. A. McLean, 1036 McMillan Ave., Winnipeg; G. A. Hoglund, 425 College Ave., Winnipeg; W. J. Hoffman, 227 Midwinter Ave., Winnipeg. Prices for above work run from \$1.75 to \$2.50 per foot for drilling and cast of pipe dia. 6-in.

Whitburch Tp., Ont.—Tenders addressed to W. H. Clarke, Clerk, Stouffville, Ont., will be received until noon, May 26, for culverts. (See official adv.).

Windsor, Ont.—City Council plans to improve Sandwich St. City Engineer, M. E. Brian.

Windsor, Ont.—A program of water mains to be laid by the Windsor Water Commission this year was approved by the Board.

Windsor, Ont.—Tenders for the widening and paving of Ouellette Ave., between Wyandotte and Erie Streets, will be called for immediately.

Winnipeg, Man.—Tenders, addressed to the Chairman, Committee on Public Utilities, will be received at the office of C. J. Brown, City Clerk, until 3 o'clock p.m., Monday, May 29, for laying a watermain in Dominion St. Specifications may be obtained at the office of W. P. Brereton, City Engineer, 223 James Ave.

Winnipeg, Man.—Public Utilities Commission recommended award of following contracts for construction of water mains: To Tho. Jackson & Sons, Minnegaffe St., from Mountain to Church St., \$600.64; Green & Elsasser, Spruce St., Wall St. and Ingersoll St., \$1,852.22; Fowler, Young & Holden, Brock St., Alfred Ave., Minto St., Boyd Ave., Dominion St. and Carter Ave., \$2,044.54.

Winnipeg, Man.—Tenders, addressed to the Chairman, Committee on Health, will be received at the office of C. J. Brown, City Clerk, until 3 o'clock p.m., Thursday, May 25, for the supply of labor and materials required for the erection of a smoke stack at Incinerator No. 3 on Saskatchewan Ave. Alternative bids will be received for the erection of a brick, concrete or steel stack. Plans and specifications may be obtained at the office of W. P. Brereton, City Engineer, 223 James Ave.

LIGHT, HEAT AND POWER

Brantford, Ont.—City Council intends to construct the following work: Concrete curb and watertable on South side of Sarah St., \$618; concrete curb and watertable on North side of Sarah St., \$466; concrete curb and watertable on South side of Terrace Hill St., \$1,269; concrete curb and watertable on North side of Terrace Hill St., \$1,269; concrete curb on West side of Rawdon St., \$165; concrete curb on West side of Ontario St., \$206; concrete curb on East side of Ontario St., \$186 concrete curb on East side of Abigail Ave., \$340; concrete curb on East side of MacLure Ave., \$346; concrete curb on East side of Maple Ave., \$340; concrete walk on East side of Dryden St., \$336; concrete walk on East side of Abigail Ave., \$107; concrete walk on South side of Sheridan St., \$417; concrete walk on South side of Elgin St., \$700; outside boulevard concrete walk on East side of St. Paul Ave., \$740; outside boulevard concrete walk on West side of Maitland St., \$535; outside boulevard concrete walk on West side of Maitland St., \$462; outside boulevard concrete walk on West side of St. Paul Ave., \$936; outside boulevard concrete walk on East side of Lyons Ave., \$366. City Clerk, H. F. Leonard.

Brantford, Ont.—City Council passed by-law providing for the raising of \$65,000 for improvements, additions and extensions to the Hydro-Electric System. City Clerk, H. F. Leonard.

Castor, Alta.—Movement is on foot for establishment of electric lighting plant. Sec.-Treas., Fred H. Tucker.

Edmonton, Alta.—On May 29 by-law will be submitted to ratepayers providing for borrowing of \$75,000 for purchase and installation of additional equipment in city's power plant. City Clerk, C. E. K. Cox.

New Liskeard, Ont.—Work is commencing at once on 6,000 h.p. development at Indian Chutes on the Montreal River, twelve miles above the town of Elk Lake, for the Matachewan Power Co., Ltd. The engineers are Sutcliffe & Neelands, Ltd., of New Liskeard.

Ottawa, Ont.—Contracts awarded by Ottawa Hydro-Electric Commission for following material: To Canadian Johns-Manville Co. for approximately 46,354 ft. of fibre conduit; Thos. Lawson & Sons, 27,310 lbs. of cast iron man-hole covers; and Dominion Bridge Co., 7,400 lbs. steel beams.

Sarnia, Ont.—Manager J. E. B. Phelps of the Hydro Commission has been authorized to proceed with the construction of an extension to the hydro-electric service lines

at the Beach down Woodrowe Road and east on the Point Edward Road, from Woodrowe to the cemetery.

Vernilion, Alta.—Improvements to the electric light and extensions to the pole line, amounting to \$6,000, will be proceeded with this summer. Sec.-Treas., H. Percy Long.

Winnipeg, Man.—Contract awarded for the construction of conduit runs to Carter-Halls-Aldinger Co., Ltd., Winnipeg. The completed work will approximate \$25,000.

Winnipeg, Man.—Construction of a \$1,000,000 standby plant for the Winnipeg Hydro-Electric system has been taken under advisement by the city officials and plans will be considered by a special sub-committee shortly.

FACTORIES AND LARGE BUILDINGS

Birch Cliff, Ont.—Bulk and separate tenders will be received by Burden & Gouinlock & Carter, Associated Architects, Toronto, until May 29, for a four-room addition to Birch Cliff Public School, S. S. No. 15, Township of Scarborough, at Stop 19, Kingston Road.

Birch Cliff Heights, Ont.—Contracts for the new Public School, S. S. No. 10, were awarded to the Carswell Construction Co., for \$57,000. Carswell Construction Co. awarded following sub-contracts on the new High School; Plastering, R. C. Dancy; excavating, Weir & Co., painting and glazing, Bavington Bros.; roofing and sheet metal, Douglas Bros.; ornamental iron and sash, Architectural Bronze Co.

Brantford, Ont.—Board of Education decided to have plans prepared for sanitary improvements recommended for Alexandra and Victoria public schools. Tenders will be called for these in the near future.

Calgary, Alta.—Contract for alterations and additions to the General Hospital Bridgeland, awarded to the Baird Construction Co., Ltd., at \$14,995.

Carstairs, Alta.—Fire damaged the Royal Hotel to the extent of \$10,000.

Cobourg, Ont.—Tenders addressed to Harry Field, Chairman, Building Committee, Cobourg Public School, will be received until 5 o'clock p.m., Friday, June 2, for all trades necessary in the erection of a two-room addition to the Cobourg Public School. Plans and specifications may be seen at the office of the Architects, Chapman, Oxley & Bishop, 506 Harbor Commission Building, Toronto.

Comtenay, B.C.—Tenders for the erection of a Masonic temple here are being called by Hiram Lodge, No. 14, A.F. and A. M. Architect, Mr. Owen, Cumberland, B.C.

Crowland Tp., Ont.—Township Council authorized W. Houthy, Township Clerk, Welland, Ont., to prepare a by-law to authorize the issuing of debentures for \$32,000 to build a four-roomed addition to Maple Leaf Park School.

Ford City, Ont.—General contract for erection of separate school has been awarded to Strain & Emery, of Windsor. Estimated cost, \$80,000.

Ford City, Ont.—Contract for erection of clubhouse for Beech Grove Country Club has been awarded to Burton & Smith. Approximate cost, \$35,000.

Edmonton, Alta.—Building permit issued for erection of Misericordia hospital estimated to cost \$205,000. Work will be done by day labor. Architect, E. Underwood.

Edmonton, Alta.—The 101st St. market building will be renovated for use as Technical School. Plans have been passed by Board of Education and tenders will be called for the work.

Edmonton, Alta.—On May 29 by-law will be submitted to ratepayers providing for the borrowing of \$175,000 for the erection of school buildings in District No. 7. City Clerk, C. E. K. Cox.

Guelph, Ont.—Robin Hood Ltd., have started work on the construction of a service station on the corner of Woolwich and Norfolk Streets.

Haileybury, Ont.—Public School Board has requested Town Council for grant of \$53,000 for repairs to Rorke Avenue School and erection of four-roomed school.

Hamilton, Ont.—C. P. Thompson, chief engineer of the Koppens Co., who will erect the new coke oven plant for

the United Gas and Fuel Co., is here to confer with the Hamilton Harbor Commission and also lay out the grounds for the plant. Work will soon be under way.

Hochelaga, Que.—Contract to rebuild the Church of the Nativity has been let at a cost of \$350,000.

Kitchener, Ont.—J. Walter & Sons plan erection of new building 100 by 200 ft.

Kitchener, Ont.—Building permit issued for Suddaby School estimated to cost \$160,000.

Lethbridge, Alta.—Contract for alterations, additions and repairs to Board of Trade Building has been let to R. W. Ronald & Co. for \$3,981. Other tenders received: T. Stubbs, \$4,225; Smith Bros. & Wilson, \$4,382, all of the city.

London, Ont.—A Methodist church is to be erected at Ealing. Address Rev. John A. Agnew.

Montreal, Que.—Fire damaged the plant of James Aird & Co., 15 and 17 St. Gabriel St., to the extent of \$40,000.

Montreal, Que.—A very large Anglican church is to be erected in Notre Dame de Grace to be known as "Trinity Memorial Church." Address Rev. Canon Almond.

Montreal, Que.—A permit has been issued to the trustees of the parish of St. Eusebe d'Vercil to construct a church at a cost of \$275,000. A permit has also been granted the Dominion Fathers to build a monastery to cost \$190,000.

Mount Dennis, Ont.—Business men of Mount Dennis requested G. T. R. to build station here.

Olinda, Ont.—Bulk or separate tenders for building a public school for S. S. No. 5, Gosfield South Township, will be received by M. McDonald, Secretary, R. R. No. 2, Ruthven, Ont., until 5 p.m., Thursday, June 1. Plans and specifications may be seen at the home of Mrs. Horatio N. Fox, Olinda, or at the office of J. C. Pennington, Bartlett Building, Windsor, Ont.

Ottawa, Ont.—Campaign will be launched by Ottawa Association for Blind for funds to erect home. Address J. L. Payne, President.

Ottawa, Ont.—Contract awarded to Bate-McMahon Co., of this city, for excavation of new High School at Highland Park, for \$2,200.

Owen Sound, Ont.—City Council passed by-law authorizing the raising of \$200,000 for addition to Collegiate Institute.

Peace River, Alta.—Contract for erection of an \$8,000 creamery plant has been let to Gander & Clarke, of Peace River.

Pembroke, Ont.—Contract for erection of Cottage Hospital has been awarded to Wm. Markus, Ltd., of Pembroke, at \$79,000.

Peterboro, Ont.—Ratepayers decided to accept offer of the Carnegie Corporation to contribute \$5,000 towards a public library in Norwood.

Powell River, B.C.—Tenders will be received by the Hon. the Minister of Public Works, Victoria, until 12 o'clock noon, Wednesday, May 31, for the erection of a two-room addition to present school building. Plans and specifications may be seen at the office of the Government Agent, Court House, Vancouver; Dr. G. S. Henderson, M.D., Secretary to School Board, Powell River; or the Department of Public Works, Victoria.

Riverside, Ont.—On June 5 by-law will be submitted to ratepayers to authorize erection of a Town Hall, Police Station and Fire Station. Also by-law providing for borrow of \$20,000 for purchase of site. Clerk, C. J. McHugh.

St. Laurent, Ont.—Tenders will be received until 6 o'clock p.m., Friday, May 26, by the Dissident School Board of Saint Laurent, addressed to Mr. Tasse, Notary, Sec.-Treas., for the erection of a schoolhouse. Plans and specifications may be examined at the office of Bigonnesse & Bigonnesse, Architects, 153 Peel St.

Sarnia, Ont.—The C. H. Wills Co. has selected a site here for the erection of a plant.

Stratford, Ont.—City Council passed by-law providing for raising of \$70,000, the cost of erecting the new Anne Hathaway School.

South Porcupine, Ont.—Clifton-Porcupine Mines plan erection of mill.

Tillsonburg, Ont.—Tenders are open for four schools, with an aggregate cost of \$75,000, and two more are contemplated.

Toronto, Ont.—Members of Eglinton Methodist Church plan erection of new church. Pastor, Rev. E. H. Toye.

Toronto, Ont.—Board of Education approved plans and specifications for the remodelling of Dundas Street School.

Toronto, Ont.—Separate School Board has purchased site on Weston Road for erection of school some time in the future. At present a house on the site will be converted into a temporary school.

Toronto, Ont.—Board of Education awarded following contracts for various trades for Riverdale Technical School: Masonry, stone, structural steel, ornamental iron, steel sash, carpentry, roofing, plastering, marble, mastic flooring and painting, Witchell & Son, \$577,370; plumbing, heating, heat regulation and refrigeration, W. G. Edge Co., Ltd., \$112,000; ash hoist, Elevator Specialty Co., \$1,596; wiring, Canada Electric Co., \$24,700; telephones, Bates & McPherson, \$1,153; time clocks, Ryrie Bros., Ltd., \$1,870.

Toronto, Ont.—Tenders, addressed to W. W. Pearce, Business Administrator and Sec.-Treas., Board of Education, will be received until Thursday, May 25, for (1) ornamental iron, roofing and tinsmithing, lathing and plastering, painting and glazing for Parkdale Collegiate; (2) ornamental iron, roofing and tinsmithing for Roden School; (3) structural steel, local phones for Norway School; and (4) hardware for North Toronto High School. Specifications may be seen at office of architect of Board, 155 College St.

Toronto, Ont.—Tenders, addressed to W. W. Pearce, Business Administrator and Sec.-Treas., Board of Education, Administration Bldg., 155 College St., will be received until Wednesday, June 7, for (1) masonry, cut stone, structural steel, steel sash, ornamental iron, carpentry, plumbing, heating and ventilating, heat regulation, electric wiring, local phones, for Jarvis Street Collegiate; (2) painting and glazing for High School of Commerce. Specifications may be seen at the office of the Architect of the Board, 155 College St.

Toronto, Ont.—Board of Education awarded following contracts for work on schools: Manning Ave. School—Masonry, Witchall & Son, \$4,450; structural steel, McGregor & McIntyre, \$783; carpentry, Hudson & Moseley, \$5,964; roofing, W. E. Dillon Co., \$675; plastering, A. D. Grant, \$1,240; painting, James Casey, \$575; plumbing and heating, Mechanical Trades Co., \$2,633; electric wiring, Canada Electric Co., \$163; local phones, Bates & McPherson, \$210. Kimberley School—Ash holst, Elevator Specialty Co., \$740; McMurich School—Ash holst, Elevator Specialty Co., \$768.

Vancouver, B.C.—A three-room addition will be constructed to Strathcona School.

Winnipeg, Man.—Tenders will be received at the office of the Winnipeg Public School Board 5 p.m., Monday, May 29, for the erection of a stone and brick fourteen-room school building on corner of Mountain Ave. and Parr St., Winnipeg. Separate tenders for plumbing, heating and ventilating will be received. For plans and specifications apply to J. B. Mitchell, Commissioner of Buildings, School Board Offices.

Woodstock, Ont.—Building operations aggregating over \$100,000 have been and will be launched during the present month, including the following: Large addition to plant of William Baird & Son, Dundas St. East; alterations and additions including new front to store of E. J. Canfield, Dundas St.; erection of new service station on Peel St., contract for which has been awarded to J. D. Tindall and Son, of this city; construction of an addition to plant of A. L. Beauregard on Peel St. south of market building; erection of large service station on Dundas St. East by A. Hastings & Son; and erection of central office for Bell Telephone Co. on Graham St.

MISCELLANEOUS

British Columbia, Province of.—Hon. John Hart, Minister of Finance, has called for tenders on an issue of \$2,000,000 bonds for irrigation and other purposes.

British Columbia, Province of.—Provincial charters have been granted to following companies: Northern Mining Properties, Ltd., Vancouver, \$417,000; North Western Dredging Co., Ltd., Vancouver, \$50,000.

Calgary, Alta.—Contract let to General Supplies, Ltd., of this city, for a 2½-ton truck chassis (Nash) with Mead-Morrison side-winch, price \$3,225 f.o.b. Calgary.

Condensed Advs.

Advertisements (not displayed) under this heading at following rates per insertion, with sixty-five cents per insertion as minimum rate in any case: "Positions Wanted," two cents per word; all other condensed advertisements, four cents per word. Payable in advance; 50 per cent. extra if charged.

GENERAL ENGINEERING AGENCY, PITTSBURGH, PA. Serving Employers everywhere overnight, require for proposals Structural Engineers, Architects, Designers, Hydro-Electric Power field and office executives and assistants, Reinforced Concrete Draftsmen, Electrical Draftsmen, Mechanical Draftsmen. —323.

"RICARDO" engines. Petrol or Paraffin, excellent for marine, commercial or stationery use. Brand new. 100 h.p. 4-cylinder, 150 h.p. & 255 h.p. 6-cylinder, 300 h.p. 12-cylinder, Thirty shillings per horse-power sterling London. Sykes, Patching, Sussex, England. —336.

POSITION WANTED: Civil Engineer with eleven years' experience in general civil work since graduation, and recently specializing in concrete, wishes to get in touch with reputable firm handling reinforced concrete work. Also fully qualified to take charge of field or office work in water power investigations. Salary \$250.00 per month. Best references, Box 50, Canadian Engineer, Toronto.

PATENT NOTICE: Any one desiring to obtain the invention covered by Canadian Patent No. 200543, granted on June 1, 1920, to Thomas Gordon Jones, of London, W. C. I., England, for Metal Seal, may do so upon application to the undersigned who are prepared to supply all reasonable demands on the part of the public for the invention, and from whom full information may be obtained. Fetherstonhaugh & Co., Ottawa, Canada. Russel S. Smart, resident. —337.

PATENT NOTICE: Any one desiring to obtain the invention covered by Canadian Patent No. 200955 granted on June 15th, 1920, to Frederick William Hall, of Westminster, S.W.1., London, England, for Coin Collecting Means for Telephone Services, may do so upon application to the undersigned who are prepared to supply all reasonable demands on the part of the public for the invention and from whom full information may be obtained. Fetherstonhaugh & Co., Ottawa, Russel S. Smart, resident. —338.

PAVEMENT TENDERS.

Sealed Tenders will be received up till noon Monday, June 5, 1922, at the office of the Town Clerk, Mimico, Ont., for Concrete and Asphalt Pavements. Plans and specifications may be seen at the office of the Engineers, Harkness London and Hertzberg, Confederation Life Building, Toronto. —334.

Exeter, Ont.—Engineer Patterson was here recently surveying for a new trunk drain on Andrew St.

Hamilton, Ont.—Plans for improving Hamilton's harbor were discussed recently by members of the Harbor Commission, Board of Control and J. M. Wilson, Engineer of Federal Department of Public Works.

Hamilton, Ont.—In the event of the plans of the Harbor Commission materializing this year, in the neighborhood of the one million dollars will be spent on waterfront development next winter. A revetment wall opposite Burlington St. will also be constructed.

Kapuskasing, Ont.—Detailed plans covering the model town which is to be built here under the supervision of the Ontario Government, have been submitted to the Legislature in a report prepared by J. A. Ellis, Director of the Bureau of Municipal Affairs.

Montreal, Que.—Tenders will be called shortly by the Shamrock Athletic Association for an addition to the grandstand at the Shamrock grounds.

Ontario, Province of.—Following are names of companies recently incorporated under Provincial charter, with head office, capitalization and name of one director: Silver Mining Co., Ltd., Cobalt, \$500,000, John Sainio; Canadian Lorrain Silver Mines, Ltd., Halleybury, 2,000,000, Edwin W. Kearney; Hanover Cement & Stone, Ltd., Hanover, \$1,500,000, Wm. S. Walton; Independent Builders, Ltd., Toronto, \$40,000, Archie B. Bennett; Lackawanna Tubes, Ltd.; Welland, \$525,000, David Ross; Toronto Junction District Orange Building Co., Ltd., Toronto, \$100,000, Timothy C. Rogers.

Ottawa, Ont.—House of Commons passed the C. P. R. bill respecting construction of branch lines in Saskatchewan and Alberta.

Ottawa, Ont.—Following are names of companies recently incorporated under Dominion charter, with head office, authorized capital and name of one director: Heath Unit Tile, Ltd., Toronto, \$50,000, Jas. W. Bicknell; Barnett-McQueen Construction Co., Ltd., Fort William, \$183,000, Otto F. Strange; Success Electric Products Co., Ltd., Ottawa, \$50,000, Wm. E. Hoare; Elbow Lake Mines Corp., Ltd., Montreal, \$3,000,000, Jos. A. Martin; British Metal Corp. (Canada) Ltd., Montreal, \$100,000, C. G. Heward; Coniagas Alkali & Reduction Co., Ltd., Thorold, \$400,000, Thos. N. Hicks; Okema Mines, Ltd., North Battleford, \$1,000,000, Albert W. Beatty.

Quebec, Que.—Following are the names of firms companies recently incorporated under Provincial charter, with head office, capitalization and name of one director: Economic Building Store (Ltd.), Montreal, \$250,000, Jos. Laureat Mascoux; Adanac Construction Co., Ltd., Montreal, \$50,000, Bernard Bourdon; Montmorency Paint Products Co., Ltd., Quebec, \$75,000, Pierre Jobidon; Safety Electric Motor Co., Joliette, \$229,000, Felix Vanasse.

Regina, Sask.—Canadian National Railways will construct a second crossing on Campbell St.

Riverside, Ont.—Town Engineer Code submitted plans and specifications to the Town Council for the removal of the Hydro-Electric suburban tracks throughout the municipality from the side of Ottawa St. to the centre of that thoroughfare, this improvement to extend for over three miles through the town.

Toronto, Ont.—Dominion Government voted \$850,000 for carrying on the work of improving the harbor here, and \$50,000 for work on the breakwater at Toronto Island.

Toronto, Ont.—A report on the proposed development of the waterfront east of Woodbine Ave. will be made at an early date by Commissioners Forman, Harris and Chambers, and Chief Engineer Cousins of the Harbor Commission.

Toronto, Ont.—General Manager H. H. Couzens of the Transportation Commission estimates the cost of making necessary changes in the transmission lines, in case it is necessary to operate the Street Railway System by Hydro power after September 1, at \$450,000.

Windsor, Ont.—T. U. Fairlie, Chief Railway Engineer

of the Hydro-Electric Commission, submitted to the Transportation Committee a plan for obviating the traffic menace on Sandwich St. East, by removing the south track and, in that way, widening the roadway to 24 ft. Proposal will be recommended to City Council for endorsement.

Winnipeg, Man.—Tenders addressed to the Chief Engineer, Canadian National Railways (Western Lines), Winnipeg, until 12 o'clock noon, Wednesday, May 31, for the following work: (1) Construction of a cast iron pipe line at Kindersley, Sask., 16,200 ft. long; (2) construction of a line revision of the Grand Trunk Pacific main line, 3.9 miles long, between Ansell and Bickerdike; (3) construction of a connection between the Canadian Northern and Grand Trunk Pacific Railways, .83 miles long, near Magnolia, Alta.; (4) construction of a connection between the Bashaw and Battle River Subdivision, 3.47 miles long, near Camrose, Alta.; and (5) construction of a connection at Ryley, 1.83 miles long, between the Viking and Battle River Sub-divisions, Canadian National Railways. Plans and specifications may be seen at the offices of the Chief Engineer, Winnipeg; District Engineer, Saskatoon; District Engineer, Edmonton; Division Engineer, Calgary; Division Engineer, Regina; Assistant Engineer, Maintenance of Way, Vancouver, and District Engineer, Prince Rupert, B.C.

RAILWAYS

Edmonton, Alta.—Supt. J. L. Jamieson of the C. P. R. announced that the company is considering the erection of a pumping plant on the south side.

Fort William Ont.—Tenders were received until May 19 for the construction of new yard at Fort William, Ont.; standard No. 4A section house, Oak Lake, Man.; and standard No. A3 station and freight shed at Niverville, Man., for Canadian Pacific Railway. District Engineer, J. C. Holden.

Montreal, Que.—Montreal Tramways Co. plans to construct a double-track line along Shakespeare Road and double-track its line on Cote des Neiges Road, north from Westmount Boulevard. Wellington St. line will be rebuilt.

North Bay, Ont.—T. & N. O. R. Railway Commission has voted \$200,000 extra expenditure to bring its tracks to

Irrigation was again the subject which engaged the attention of the members of the Edmonton Board of Trade at one of their regular weekly luncheon meetings. The meeting was in charge of the engineering and construction section of the Board of which L. E. Drummond is chairman. Addresses were given by S. G. Porter, engineer in charge of construction and maintenance of the Lethbridge section of the C.P.R. irrigation system; V. Meek, federal commissioner of Irrigation, Calgary, and G. N. Houston, secretary of the soil survey board and Irrigation council of Alberta. Mr. Porter was the main speaker and all dealt with the subject of "The Cost of Irrigation in Southern Alberta."

It is expected that operations on sections Nos. 1 and 2 of the Welland ship canal will begin soon. The Government's appropriation of \$8,000,000 to carry on this year's work on the ship canal seems to indicate that the new administration at Ottawa is anxious to get the waterway completed. It is believed section No. 9 at Thorold will be given over to a private contractor. At present the Government is operating section No. 3 with a thousand men.

As soon as the weather allows, work on a large scale will be commenced on sections one and two of the Welland Ship Canal, which contracts are in the hands of Porter Bros. At present the canal zone is very muddy, and work is being carried on with difficulty. Section three, at Thorold, is under Government contract but it is believed this section and those above Thorold will soon be let to private contractors. There is a large amount of rock excavation yet to be done on Thorold section, which is the most expensive section on the whole waterway.



The Contractor's First Choice Always

The Waterous double cylinder steam roller has been the first choice of contractors for over twenty-five years. That the confidence placed in the Waterous roller by the contractors of Canada is fully upheld is evidenced by the fact that when in need of additional rollers they insist on Waterous. This is because the Waterous roller is designed and built to earn money for its owner. Every detail of its engineering, every inch of the tested material in it, contributes directly and always to this one end.

Some years ago Wentworth County kept accurate costs of a Waterous roller and one of another make. The result showed that the Waterous roller worked in one year 202 days of 10 hours each and 76 nights, of 12 hours each. The cost of repairs was \$189.00 which was practically the total cost of repairs incurred since it was bought, and it has been in service five years.

The other make of roller was in operation 129 days of 10 hours each, and 18 nights of 12 hours each and cost \$197.00 for repairs, being in operation four seasons.

The above figures show that the Waterous roller not only did 250 per cent more work but did it at a maintenance cost of 23 percent less.

Waterous

BRANTFORD, ONTARIO, CANADA

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Substructure of Edmundston-Madawaska Bridge*

International Highway Bridge of Four 232-Ft. Spans Replaces Cable Ferry Over St. John River — Piers on Well-Compacted Sand and Blue Clay Containing Boulders — Reinforcement at Pier Faces — Pontoon Construction

By G. McN. STEEVES

CONNECTING the Town of Edmundston, N.B., and the Village of Madawaska, Maine, an important new highway bridge is now being constructed across the St. John River. The highways on both sides of the river, which, at this point constitutes the international boundary, are modern and well kept, and maintain a very heavy traffic. Until the bridge is ready for crossing, the only means of transfer during the period of open water, from one system of highways to the other, is by means of a cable ferry plying a few hundred yards below the site of the bridge. During the time of making ice, and also when the latter is breaking up and running out, the crossing is interrupted for weeks at a time. When the water is low, as was the case during the past summer, constituting a record, there is current barely sufficient to operate the ferry. Thus the conditions noted seriously affect traffic at this point.

Edmundston is a growing town of approximately 5,000 people. It serves a large outlying agricultural and lumbering district on both sides of the river. Madawaska is a rural community depending on Edmundston for immediate physical needs and professional services.

The nearest all the year crossing is between St. Leonard's, N.B., and Van Buren, Me., 26 miles below this bridge, while on the upper side, there is no crossing excepting a foot bridge between Clair, N.B., and Fort Kent, Me., some 20 miles west. Means to improve the lack of facilities thus

awarded in February, 1921, for the carrying out of the work.

Governing Layout Conditions.

Features to be mainly considered in the choice of the actual site were two in number: (1) Elimination of railway grade crossings, and (2) Safe clearance above high water.



FIG. 2—COMPLETED WORK—CANADIAN ABUTMENT IN FOREGROUND

Two lines of railway, the Transcontinental and Temiscouata, pass through Edmundston, skirting the river bank at an elevation approximately 3 ft. above the level of the highest water recorded. The road leading to the ferry crossing passes under the Transcontinental tracks, so, therefore, this site could not be used without the introduction of a level crossing. To satisfy both above conditions, it was necessary to build the structure over the railway lines.

The clearance required between the top of rail and the under side of any overhead structure is nearly 23 ft. A suitable location which would provide approaches to a structure of these requirements was available at the extension of a reserved street in the town, and its prolongation across the river, where the top of the bank was about the same elevation as that on the Canadian side.

In passing, reference is made to the fore-sight of an early resident of the town of Edmundston, who, at the time of the high water of 1885, the highest level recorded, marked on a large boulder the water line at that time, and authenticated it with the legend inscribed on the rock: "Water came to here April, 1885."

The bank on the Canadian side is ledge rock, overlain with pockets of clay. The American bank is gravel, very compact, with an 8 ft. layer of clay overburden. The river



FIG. 1—VIEW FROM MAINE SHORE, SEPT. 29, 1921

endured by residents of the district, had been under consideration of the Governments of Canada and of the State of Maine for some years. The war interfered with the carrying out of a bridge project earlier than 1920. In that year tenders were called for, and a contract was

*Paper presented to the St. John Branch, Engineering Institute of Canada.

bed is composed of coarse gravel and boulders, varying from a foot to 3 ft. in thickness, overlying very hard sand and blue clay, mixed.

During high water periods, the current over the full width is swift, probably 8 miles per hour, but, owing to the sharp gradient, floods soon run off. During low water, the current is reduced to about 3 miles per hour, and is

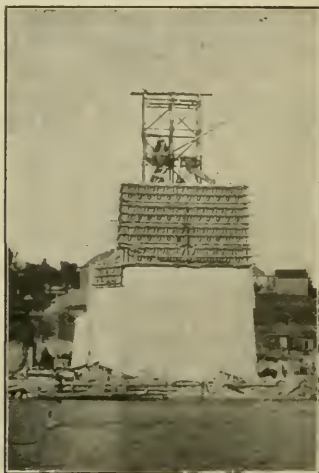


FIG. 3—CONCRETING PIER NO. 2—PANEL FORMS READY FOR SPOUTING

confined within a channel about 200 ft. wide, adjacent to the Canadian shore, the balance of the river being comparatively slack water. The width of the river at high water is about 850 ft. and at low water 200 ft. less. At low water the depth varies from 2 to 7 ft. at this crossing. All elevations are referred to mean sea level. Low water is elevation 441.85, and high water, the elevation of the boulder referred to, is 467.85.

Description of Structure.

The bridge is being built under two separate contracts, one covering the foundation work or substructure, and the other the steel superstructure. The first of the foregoing will be dealt with at this time.

Piers.

The substructure consists of two concrete abutments and three semi-reinforced concrete piers, as shown in Figs. 1 and 2. The distance between face of ballast walls of each abutment and the centre of next adjacent pier is 235 ft., 6 in., which is also the distance between piers.

Each pier rests on a footing course of varying depth in the case of each, the maximum being 10 ft. under pier 2. This footing course is built inside a sheet pile cofferdam, which in turn is enclosed within a cribwork protection and stone rip-rap. The top of footing course is elevation 442.0, or 0.15 above extreme low water.

The main body of the piers is rectangular in plan, with a triangular shaped cutwater on the up-stream end, and a triangular shaped buttress on the down-stream end, as shown in Figs. 3 and 4. The nose of the cutwater is protected by an 8 by 8 by $\frac{3}{4}$ -in. steel angle. The piers are 8 ft. 6 in. by 29 ft. at the top and 58.54 ft. high above the top of the footing course. The sides are battered 1 in 20.

The average elevation of river bed is 438.0. The footing course was required to extend at least 6 ft. below river bed. A suitable bearing was obtained at this minimum in the case of the two shore piers. A mattress of steel reinforcement of 1 in. square twisted rods was placed

within a foot, or as near that as possible, of the bottom of the concrete of the footing course. The rods were spaced 12 in. in each direction. Vertical rods, at 12-in. centres, of the same dimensions were hooked into this mattress, and carried near the faces of the piers, as construction proceeded, to within a few feet of the top of the pier. Horizontal $\frac{3}{4}$ -in. square twisted reinforcing at 2 ft. centres was carried up with the verticals. Splices and intersections were wired with No. 16 gauge Bates wire ties.

Abutments.

The Canadian abutment rests on solid rock. It is a type of "U" abutment, somewhat out of the ordinary in the design of the walls. The centre line between trusses of the superstructure is eccentric downstream to the centre line of the abutment, to permit the foot walk to be carried on the inside of the upstream wing wall. This accounts for a buttress on the lower side of the abutment. The sidewalk on the superstructure is to be cantilevered from the truss. Reinforcing bars of 1 in. square twisted steel were placed in the inside corners at the junction of the main wall with the wings. These were 12 ft. long and bent in the centre to a right angle.

The foundation for the American abutment is fine compact gravel, with 8 to 10 ft. of clay overburden. Owing to the presence of water at several points in the bank, adjacent to the site of the abutment, but not in the immediate vicinity, the original plans called for a pile foundation with an elaborate arrangement of batter piles to be driven. The carrying out of the original plan was attempted, but amounted to the driving of only one pile a distance of $4\frac{1}{2}$ ft. under a 2,400-lb. hammer. The design was altered and the former level of excavation for footing course was lowered 5 ft., resulting in placing the foundations well inside the bank. Over the bottom of the exca-



FIG. 4—CONCRETING PIER NO. 1—ONE ELEVATING CAGE AT CONCRETING LEVEL, OTHER AT GROUND

vation was placed a 3-in. layer of 1:3 grout, slightly worked into the bed to bond the same before placing the footing course.

Both abutments carry on the copings reinforced posts and pre-cast re-inforced rails, as shown in Fig. 1. This part of the work was done during cold weather. Aggre-

A series of tests in the meantime was being carried out by the engineers, with the different proportions of run of bank gravel, and re-mixed screened gravel. Cubes and cylinder test samples were submitted to the testing laboratories of the Department of Public Works, Ottawa, and the University of Maine, the results from both invariably being similar in the case of each set of samples tested. The results went to show that the stronger concrete was obtained from the natural run of bank gravel; in one or two cases, samples of the latter aggregate showed double the compressive strength of the re-mixed screened gravel. Screening was therefore ordered discontinued, after 200 cu. yds. of screened gravel concrete had been deposited.

Sequence of Operations, Pier No. 2.

The centre of the pier for placing protection cribs was obtained by direct chainage from shore. A 300-ft. tape was used, supported on gas-pipe standards driven into the bed of the river, and carrying on the top a "U" made up of tees and ells. The side lines of cribs were set with a box sextant.

Each protection cribwork consisted of four separate cribs: (1) Nose piece 46 ft. 10 in. across the base, and 23 ft. 2 in. perpendicular distance to the apex; (2) Two side cribs, 62 ft. 10 in. long and 9 ft. 0 in. wide; (3) One closure crib 46 ft. 10 in. by 9 ft. 0 in., extending across the down stream ends of the last two cribs and the enclosed space between them. The cribs were built of 8 in. to 10 in. logs in 8 ft. bays. Ballast floors were provided. When completed and finally in place, the cribs were to

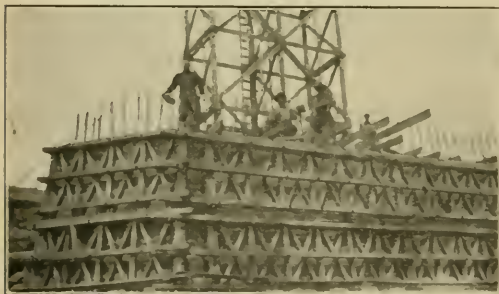


FIG. 7.—FOURTH LIFT (20 FT.) OF PANEL FORMS, PIER NO. 1—PREVIOUS TO PLACING SLIDING HOPPERS ON TOWER

stand 2 ft. above low water. The maximum height built was 8 ft. When finally in place, the cribs were filled with stone and clay, and banked on the outside with clay, the latter to assist in making watertight the cofferdam subsequently to be built inside. The centre line of the pier was now accurately set by triangulation, and checked by chainage. From these the lines to which the cofferdam was to be built were laid on the cribwork. The cofferdam was also the form work for the foundation course.

Sheet Piling.

The cofferdam consisted of sheet piling built up of two 2 by 8 in. planks, half lapped, spiked together; preparatory to driving, the piling was stood on end around a frame composed of timbers varying in size from 6 by 8 in. to 12 by 12 in., according to the depth it was anticipated the piling would be driven. From the character of the material of the river bed, it was reasonably certain that the sheeting would not stand hard driving. A power hammer was therefore not installed.

Up to this point, the conditions obtaining in all three pier sites were similar. From borings made on this pier site, it was found that the material to be excavated contained more sand, and the hard stratum on which the footing course was to rest, was 4 ft. deeper than at the other

piers. Timbers 12 by 12 in. were used in the framework for this cofferdam.

The water inside the protection crib was 4 ft. deep. The river bed was roughly levelled off, and a frame was built, the outside dimensions of which corresponded to the dimensions of the footing course. This was centred and held in position. Short posts about 4 ft. long were stood up on the first frame, and a second frame was constructed on the top of these posts. This double frame was weighted and sunk. The sheeting was then placed around the four sides of the framework. Clay puddle was next placed in the 6-ft. space between the outside of the cofferdam and the crib protection, to a height of 2 ft. above the water level. The water was then pumped out to permit of excavation. This was done by hand, the material loaded into skips, and dumped outside the cribwork. The material was too hard to be dug with a clam shell. As the bottom was lowered the sheeting was driven with large wooden mauls. Great care had to be exercised in driving not to broom the pointed ends of the sheeting. The driving followed closely the hand picking at the foot of each pile.

As the excavation was lowered, additional frames were set in under the first two. Cross timbers were jacked into prevent the sheeting crowding, a tendency that was ever present owing to the large number of boulders that had to be removed away from the cutting edge. These had to be broken up, causing a disturbance of the bed, outside of the sheeting, which increased the leakage to such an extent that eventually two centrifugal suction pumps, one 6 in. and one 8 in. were required to keep the water down to the level at which excavation could be carried on.

In other piers, it had been possible to have the caisson dry enough to concrete up to a set of walings, remove these and proceed with the concrete. In the present case, this was not possible, because of the leaks, and the foundation course was deposited under water to a depth of 5 ft. above which the amount of leakage was negligible.

The timber wales and braces were replaced by S0-lb. rails and left in the concrete.

Concrete was deposited under water by means of bottom dump buckets. After 4 days, the water was pumped off, the surface thoroughly broomed, the reinforcing steel mattress laid, and concreting resumed to top of footing course.

Forms.

Wooden panel forms, of the type illustrated in Figs. 6 and 7, were employed. Specials were re-used on all piers in a corresponding position three times. The regular rectangular form was used over and over again, as often as required. Form lumber was 1½ in. T. & G. clear spruce, fastened to 3 by 5 in. framework. The height of the sections was 5 ft., which gave a batter of 3 in. in each lift. The forms were laid out and built on a specially constructed platform, where the outline of the horizontal plane through the pier at each succeeding 5 ft. lift could be accurately laid out. When placed on the pier, the forms fitted perfectly. Check levels for the bridge seat differed from the elevation of the forms by not more than ¼ in.

Forms were tied together with two wire ties to each bolt, projecting through the forms. These ties were previously prepared on Newburgh's wire tie machine. Any slack was taken up by twisting the bolt head against a wrench held on the nut. After the concrete had set four or five hours, the head was broken by giving the bolt a backward turn.

The forms were left on for three days. To remove them, the bolts holding the wire ties were backed out, then the bolts holding adjacent sections were taken out. A sling attached to the fall of the tower derrick was hooked into the upper waling of the form section, which was then wedged off at the bottom, and the form was raised to the next lift, or lowered to the ground as required.

Conclusion.

Tongued and grooved lumber did not prove entirely satisfactory. The dampness in the concrete caused the

tongue to swell, and pushed the inner side of the groove into the concrete. With forms new, this was more marked than after they had been used several times. Before being re-used, forms were planed and oiled. Lumber dressed on three sides was used for forms on the abutments, and proved entirely satisfactory.

The concrete used in the bridge seats and copings was mixed in the proportion of 1:2:4. For the rest of the work it was 1:3:5, except for sidewalks and railings, for which it was 1:3 mortar.

Twenty-nine carloads of cement, 150,000 lb. of steel reinforcing, and over 5,000 cu. yd. of gravel were used in the job.

Work was started May 10, and completed Nov. 26, 1921. The date of completion set by the contract was Feb. 20, 1922. The maximum number of men employed at one time was 120.

The contractors were D. C. Burpee & Son, Devon, N. B., with whom the writer was associated. S. J. Chapleau, was engineer-in-charge for the Department of Public Works (Canada), and had L. DeB. Roy, assistant engineer, as his representative on the work. L. N. Edwards represented the Maine State Highway Commission, his deputy on the work being H. E. Towne. A. W. Gregory, of the Department of Public Works, represented both governments as inspector of materials.

CANADIAN WATER-POWERS.

CANADA is richly endowed with water-power resources. Practically every large industrial centre throughout the Dominion is now served with hydro-electric energy and has within easy transmission distance ample reserves of water-power. Over 90 per cent of the prime motive power of the central electric station industry of Canada is hydro power.

The administration of the water resources of the Dominion is a divided federal and provincial responsibility. In Alberta, Saskatchewan, Manitoba, and the Yukon and Northwest Territories, control is vested in the Dominion Water Power Branch, Department of the Interior. Throughout the remainder of Canada, administration is carried out by the following respective provincial authorities: British Columbia, Department of Lands; Ontario, Department of Lands and Forests; Quebec, Department of Land and Forests; Nova Scotia, Commissioner of Public Works and Mines; New Brunswick, Department of Lands and Mines; Prince Edward Island, Commissioner of Public Works.

In Manitoba, Ontario, New Brunswick and Nova Scotia, commissions under the Government have been formed to develop or purchase power and to transmit and distribute electric energy. The greatest development in this field has been in Ontario through the Hydro-Electric Power Commission, formed in 1905. In general, the commission acts as administrator for municipalities undertaking to co-operatively purchase or develop electric energy; it also acts as trustee for the Provincial Government, the financing of the enterprises being backed by the Government. In 1919 the commission was delivering power to 217 municipalities and was operating in all fourteen power plants, developing a total of 284,449 h.p. The Manitoba and Nova Scotia Power Commissions, formed in 1919, and the New Brunswick Electric Power Commission in 1920, have much the same functions as the Hydro-Electric Power Commission of Ontario. In Manitoba the commission purchases power from the city of Winnipeg and transmits it to Portage la Prairie and other towns in the southern part of the province. In New Brunswick and Nova Scotia the commissions are engaged in the development of hydro-electric powers which will serve in the near future the cities of St. John, N.B., and Halifax, N.S. In the province of Quebec there is no Government commission engaged in the production or distribution of electric energy. The Quebec Streams Commission is, however, actively engaged in the examination of rivers and power sites and the construction of storage basins for water-power purposes.

The water-wheels installed throughout the Dominion total 2,470,580 h.p. A detailed analysis of the relationship between this installed power, taking into consideration local pondage and load factors, and the corresponding available water-power, indicates that the at present recorded available water-powers of the Dominion will permit of a turbine installation of 41,700,000 h.p. In other words, the present turbine installation represents only 5.9 per cent utilization of the present recorded water-power resources. In support of this statement it may be said that the detailed analysis made of the water-power resources of the provinces of New Brunswick and Nova Scotia have disclosed most advantageous reservoir and pondage facilities for regulating stream flow, and it is estimated that, allowing for the diversity factor between installed power and consumers' demands, the two provinces possess respectively 200,000 and 300,000 commercial h.p. as against the lower figures given in the table.

With a water-power development of 275 h.p. per 1,000 population, Canada stands well to the fore in respect to availability and utilization of hydro-power resources, being surpassed on this basis by Norway alone. The enormous water-power reserves still untouched form a substantial foundation for the progressive exploitation and development of other natural resources, especially if properly co-ordinated with the development and utilization of the well-known fuel resources of the Dominion.

APPROPRIATIONS FOR NATIONAL RAILWAYS.

APPROPRIATIONS to meet requirements of the National railways, amounting to more than \$90,000,000, were approved in rapid succession after some hours' discussion in committee of supply in the House of Commons recently. The appropriations approved were as follows: \$42,800,000 to meet operating deficits, to pay for property, materials and supplies, to meet interest and sinking funds on notes, securities or obligations, principal and interest or maturing or matured loans, construction and betterments, co-ordination or consolidation of railway lines and facilities on the Canadian Northern system. \$25,750,000 for like purposes on the Grand Trunk Railway system; \$15,900,000 for like use in connection with the Grand Trunk Pacific railway; \$2,800,000 to be advanced for the purchase of repair of equipment for the Canadian Northern and Grand Trunk Pacific; \$2,700,000 for construction and betterments on the Canadian government railways, that is, the Intercolonial and Prince Edward Island railways and the National Transcontinental railway as branch lines for the Intercolonial: \$40,000 for and Moncton railway and the Caraquet and Gulf Shore railway as branch lines for the Intercolonial: \$40,000 for maintenance of the Hudson Bay railway terminals at Port Nelson; \$30,000 to pay claims for right of way on the Canadian government railways—a total of \$90,170,000.

The Canadian Western Natural Gas, Light, Heat and Power Co., has acquired outright a big block of natural gas rights, embracing the most important holdings in the Redcliffe field, near Medicine Hat, Alta., which will guarantee even more than an adequate supply of gas for Calgary. It is planned to get this gas into the main line now supplying Calgary, by means of an extension of the pipe line from the present terminus of the Bow Island pipe line to the Redcliffe field, a distance of 38 miles.

A few months ago a branch of the Engineering Institute of Canada was organized in Lethbridge, Alta., and has proved very successful. At present there are over sixty members and affiliates attached to the branch. C. M. Arnold, assistant chief engineer of the Lethbridge Northern Irrigation District, is chairman, and G. S. Brown, assistant engineer in the C.P.R. Department of Natural Resources at Lethbridge, is secretary.

TOPOGRAPHICAL SURVEY OF LONDON, ONT.*

Triangulation Net Containing Four Stations of Primary
Triangulation of Canada — Precise Level Net Con-
tains 41 Miles of Line — Method of Marking
Stations and Bench Marks.

By Douglas H. Nelles,

Supervisor of Topography, Geodetic Survey of Canada.

TOPOGRAPHICAL surveying of a city consists of six, more or less, distinct operations: precise level net, secondary level net, triangulation net, traverse net, the measuring in the natural and artificial features to be shown on the map, and the locating of the contours showing the modeling or configuration of the ground surface.

The triangulation net is surveyed by engineers from the triangulation division of the Geodetic Survey, who work in close co-operation with the engineer in charge of the topographical division, especially during the reconnaissance work in locating stations. The main object of the triangulation is to control the traverse net, and stations are placed as nearly as possible a mile apart along the main traverse lines. The London net consists of thirteen stations from which observations were made and eight intersection stations as shown in Fig. 1. Four of these stations form a quadrilateral of the primary triangulation of Canada. The remaining stations were established during the season and are placed so as to form a precise control for all lineal measurements of the survey. The net was adjusted by the co-ordinate method of adjustment. A more detailed account of this operation by the engineer in charge will be found below.

The precise level net is surveyed by engineers from the levelling division of the Survey, who also work in close co-operation with the engineer from the topographical division. The object of a precise level net is to establish a large number of permanent bench-marks around and through the city, of a high degree of precision, which while giving elevations themselves for any engineering work in their immediate vicinity, also serve to control lines of secondary levelling.

The word permanent above is used in a relative sense, as in establishing the permanency of any structure the economic factor of the cost of construction has always to be taken into consideration. If a copper bolt had been cemented into the floor of the King room in the Grand Pyramid at Ghizeh in Egypt and its elevation established, it would probably be intact today, but the probability is that in 25,000 years from now all the present bench-marks in London will have disappeared.

Precise Level Net

The precise level net of London consists of forty-one miles of line, which is composed of a line making a complete circuit of the city. The city is further divided into sections by four east and west cross lines and five north and south cross lines. The cross lines start from and close on the circuit line or themselves. The whole net has been

adjusted by least squares and the most probable values assigned to the various bench-marks. The closing error per mile of line was 0.0025 ft., and the average closing error of line between bench-marks is 0.001. Ninety-five permanent bench-marks were built and their elevations established. Fourteen of these called class "A," consisted of a concrete pier 6 ft. 6 in. long set in the ground with 6 in. above the surface in the top of which was set a 3/4-in. copper bolt to hold the elevation. Fifty-one bench-marks, class "B," consisted of a 2-in. galvanized iron pipe 6 ft. long, the bottom of which was split and spread so as to prevent vertical movement. The bottom of the bench-mark was placed 5 ft. 6 in. below the surface and concrete a few inches in depth, was placed in the bottom of the hole further to prevent vertical movement. Thirty bench-marks consisted of a copper bolt set vertically in concrete sidewalks, bridge or culvert abutments and horizontally in foundations of buildings, class "C" and "D". Further information in regard to the precise level net will be found below, and in Fig. 2.

The following is abstracted from the summary report of F. P. Steers, the geodetic engineer in charge of the topographical survey of London.

Report of Geodetic Engineer.

A system of precise traverses has been laid out for the city. These are divided by name into two classes, but the methods of survey are of about the same accuracy. The main traverse lines start from and close on triangulation stations between which the stations and controlled lines are adjusted. The secondary traverse lines start from and close on an adjusted station of the main traverse.

The traverse net is so designed that the main lines are about half a mile apart and run along the streets along which the long side of the block lies. The secondary traverse lines run along the streets which

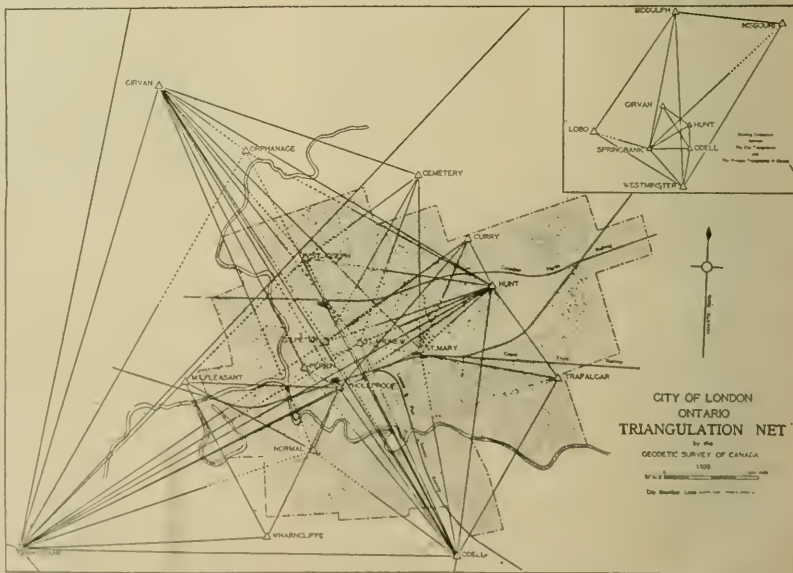


FIG. 1—TRIANGULATION NET, LONDON, ONT.

present the shortest side of the block. This placing of the lines while it gives the same number of angles to be measured, gives the shortest length of line and so decreases the cost of measurement. The system leaves one station at one corner of each street intersection, which is marked by a 1/2-in. copper bolt cemented into the sidewalk. This bolt besides constituting a distance co-ordinate, becomes a bench

*From the last annual report of the Superintendent, Geodetic Survey of Canada.

mark of an accuracy good enough for all ordinary needs of city engineering.

The traverses surveyed during the 1920 season comprise 12.5 miles of line, containing 124 stations or about 10 stations per mile; besides this 33 bolts were placed in position. The position of these lines takes in the most thickly built-up section of the city around Dundas and Richmond streets.

All distances as shown in the geographical position list of the triangulation are mean sea-level distances. All the chained measurements taken in London are at an average elevation of 280 ft. above mean sea-level, so that a distance of 5,000 ft. at mean sea-level on being projected to an elevation of 820 ft. would increase to 5000.196 ft. As errors of our traverses will be much smaller than this, the datum of the lineal measurements of London have been placed at 820 ft. above mean sea-level.

The mathematical co-ordinates of the survey will be rectangular. Holeproof triangulation station has been chosen as the zero of the co-ordinates and as the city engineer desires to have the edges of the map sheets parallel to the street lines, the datum line for the co-ordinates will be a line passing through Holeproof station parallel to Waterloo street line, or nearly so. All the bearings of the survey will be referred to this line. All the distances and bearings of the triangulation have been re-calculated on the above datums and the positions of the triangulation stations are being listed by rectangular latitude and departure co-ordinates in the same manner as the traverse stations.

Secondary Levels.

Secondary levels are run over all traverse lines and start from and end on an adjusted bench-mark. They serve four purposes; (1) to establish the elevation of all traverse bolts and thus render them permanent bench-marks; (2) to establish the elevations of such extra bench-marks at the city engineer desires to put in, these generally being of the shelf design, class "E;" (3), to obtain the elevation of the points along the traverse lines where the grade changes, thus giving information for chainage correction for grade; (4), to obtain spot levels to help out in the work of fixing the location of contours. Fourteen miles of secondary levels was run during the season, establishing the elevation of 168 permanent bench-marks, consisting of 145 traverse station bolts and 23 bench-marks, class "E." The average closing per mile of line came to 0.016 ft., which is an average closing of line between bench-marks of 0.0013 ft. The elevation of the secondary bench-marks resulting from the adjustment of the secondary level net, should be of a high degree of accuracy.

Mapping details consist of hydrants, manholes, drainage grates, fences, sidewalks, buildings, etc., being all the natural and artificial features to be shown on the map. The part chosen for the last season's work was the most congested in the city and therefore the most expensive to measure up. In this business district an engineer and two assistants averaged nine acres a day. In a residential district the average would be much higher and in open country like that in the vicinity of the asylum the average would

be around thirty acres; this would include the contours as well.

During the winter experiments have been carried on which seem to show that the details of the interior of residential city blocks can be obtained from aerial photographs with sufficient accuracy to be within the scale of the map.



FIG. 2—LEVEL NET, LONDON, ONT.

The Air Board has consented to take aerial pictures of London for the Geodetic Survey, as an experiment to see what can be done in this regard. With this information it is also intended to see how accurate a photographic mosaic of the city can be made on the same scale as the map scale.

QUEBEC ENGINEERS MEET.

AN interesting address was delivered at a meeting of the Quebec branch of the Engineering Institute of Canada held on May 23, by Alexandre Larivière, engineer of the Public Service Commission, Quebec. Mr. Larivière described the water powers in the province of Quebec and their value to industry. He described in detail the construction of the transmission lines in the province and referred to the high voltages carried from Shawinigan Falls. He said all this scientific progress which has led to wonderful results, and which is important from an economic point of view, is the fruit of the work of engineers belonging to different companies. Before them each day problems always more complex arise but they face them bravely and overcome by degrees the obstacles that arise in the operation of wires of a different kind, especially electric wires. Development in all branches of electrical genius is rapid and constant, but we are still far from the day when lines can be constructed which will be operated at 500,000 volts. In 1921 a line of 220,000 volts was built.

Announcement that the State Department at Washington has intimated to the Dominion Government its willingness to open negotiations on the St. Lawrence waterways scheme will, it is expected, bring the whole subject before the House again. On several occasions this session the House of Commons has discussed the St. Lawrence waterways scheme but without a final expression of opinion by the House, the debate on each occasion being adjourned.

FIRE PREVENTION AND PROTECTION IN MUNICIPALITIES*

Serious Increase in Fire Losses — Water Works Department Can Help by Supplying Adequate Protection — Details of Campaign in Indianapolis.

By Frank C. Jordan,
Secretary, Indianapolis Water Co.

FIRE loss in America has reached the proportions of a national calamity and we are becoming a criminally careless people. The burning of four or five hundred million dollars worth of property every year has ceased to be a matter of no concern. The increasing fire loss stands as a serious indictment of the American public. The 1921 fire loss means that five hundred million dollars worth of our natural and created resources are wiped out of existence. There is a prevailing opinion that fire insurance companies in some mysterious way make good our loss by fire. The proceeds of a fire insurance policy may reimburse the individual for the loss he has sustained but no amount of money can restore a burned structure, therefore, when a fire occurs everybody loses.

During the World War, we were very bitter in our denunciation of the German nation by reason of the wanton destruction of thousands and thousands of acres of French forests by the German army, and our papers gave picture after picture depicting the burned and damaged forests, and we took a vow that Germany must be made to pay for this damage. In the year 1921, American forests were burned equal in acreage to eight times the total acreage destroyed or damaged in France during the four years of the World War, and 75 per cent of all of our 1921 forest fires were due to human agencies and could have been prevented by care and vigilance on the part of forest users. Sufficient timber was burned in American forests last year to build 5-room houses for the entire population of such cities as Kansas City, New Orleans, Washington, Seattle, Portland, Rochester or Indianapolis. America's fire loss during the year 1921 exceeded five hundred million dollars, this amount covering insurable property only and not including loss of forests, standing grain, pasture lands etc. H. A. Smith, president of the National Fire Insurance Co., of Hartford, states in an article which appeared in the New York Journal of Commerce, that disbursements by the insurance companies during 1920 covering losses and operating expenses exceeded the losses and expenses for any other year in the history of our country with the exception of the year 1917. These figures also show that the amount paid out by the insurance companies in the year 1906, the year of the San Francisco fire, totaled \$359,642,372, and we well remember that the fire loss for that year was a serious shock to many of our great financial institutions and that it caused great concern all over our country. The losses and expenses for the year 1920 exceeded the 1906 insurance figures by one hundred and five million dollars, and generally speaking the public concerned itself very little about the matter.

Fire Losses Increase.

A comparison for the fire losses for the years 1906 and 1920 gives us an interesting slant on the workings of the public mind. The actual fire loss on created property in 1906 was \$159,710,000, an amount \$129,000,000 greater than the loss on created and insured property in 1920. Much of the San Francisco property carried little or no insurance, the insurance companies paying out only \$359,000,000 during the year 1906. The public, therefore, had first hand knowledge of the terrible ravages of fire and great was the clamor for fire prevention. This enthusiasm wore off in a short time and the public apparently contented itself by covering its property with an insurance policy and forthwith passed the burden of worry to the insurance

companies. In 1920, with a fire loss of \$330,000,000 on created and insured property, the insurance companies paid out \$464,000,000 covering fire loss and operating expenses. Having thus passed the burden to the insurance companies, and having only second hand information in regard to the ravages of fire the public did not greatly concern itself.

A careful survey seems to indicate that the only answer which our country makes to this ever increasing fire loss is to add largely to its insurance premiums and to its fire departments both in men and equipment and today our fire departments are recognized as the most efficient in the world and well they need be. American travellers to foreign lands are prone to make rather uncomplimentary and facetious remarks in regard to the antiquated fire fighting equipment maintained by the European cities, entirely overlooking the fact that while we have been busily engaged in increasing the efficiency of our fire fighting equipment the American public has been ever more busily engaged in increasing its careless habits. We are today confronted with the lamentable fact that our country, with all its wonderful development and wonderful fire fighting force and equipment, has an annual fire loss of almost \$5.00 per capita whereas the foreign countries, with antiquated fire fighting equipment but with careful habits reinforced by severe personal liability laws, have an annual per capita fire loss ranging from 11 to 60 cents.

The depletion of our resources by fire is in itself an exceedingly serious matter, but the seriousness of the financial loss is greatly exceeded by the seriousness of the loss of life due to fire, our 1920 figures showing that 15,219 persons were burned to death in the United States and 17,641 were seriously injured. 82 per cent of the dead and injured were mothers and children, and 92 per cent of the fires that caused these fatalities were the result of carelessness or negligence. Carefully prepared statistics indicate that approximately 80 per cent. of all the fires occurring in the United States are preventable.

Appeal to Water Works Association.

In view of our appalling loss of life and property, it is imperative that all great organizations, such as the American Water Works Association, give most careful attention to the question of fire protection and fire prevention and exert every effort to bring about the elimination of all of those fires which are classed as preventable. It is high time that we turn the spotlight of publicity on our fire loss, make a careful study of the causes of our fires and map out a carefully prepared campaign of education to the end that the right thinking people of this country may understand the seriousness of our fire loss and take proper steps to cut this loss to a minimum figure. This campaign of education should be followed by the enactment of rigid laws covering personal liability for preventable fires, and these laws should be enforced to the letter so that the irresponsible or evil-minded citizen will be compelled to eliminate preventable fires.

In many foreign countries, a man who has a fire must prove to the court that he was in no way responsible or he is subjected to a fine and the loss of his insurance. The time must come when the United States will enact laws covering personal liability for preventable fires. The public conscience has become dulled to the necessity for any fire prevention measures. We feel relieved when we read the words "Fully covered by insurance," and we feel that some soul-less corporation called an insurance company will shake a tree bearing a never ending crop of dollars and gather up this money and hand it to the insured, fully compensating him for all loss. We overlook the fact that our tremendous fire loss, plus the cost of operating insurance companies, is borne by all of us in the way of insurance premiums and that this amount constitutes one of our greatest national expenditures.

A few years ago the average insurance agent took very little interest in the subject of fire prevention, the fact of an increase in fire loss being used by him as an argument to his clients to take out more insurance. The progressive insurance agents of today, however, take a different view

*Paper presented at the Annual Convention of the American Water Works Association, Philadelphia, May 15-19,

of the matter, and president F. J. Fox of the National Association of Insurance Agents gives voice to the following statement: "Although it may seem to the shortsighted agent poor business to recommend to an insured that if a certain pile of rubbish is disposed of, the rate can be reduced from \$1.25 to 13 cents, as a matter of fact such advice is a part of the duty every agent owes to his clients even though such advice may reduce the actual premium rate involved." He further states that: "It is a notable fact that the press of the country has been active in aiding communities to reduce their fire losses, and it is absolutely essential that reputable agents throughout the country co-operate with every ounce of energy to the same end." No organization in the United States should be more interested in the subject of fire protection and fire prevention than the American Water Works Association, and I sincerely trust that this Association will at once go on record, pledging its unqualified support to any movement looking to the curtailing of our fire loss. I desire to speak a word in commendation of the fine service which is being rendered by the National Fire Protection Association, and to extend your support of that organization. Through the distribution of carefully prepared literature, and the putting forth of unstinted efforts in the cause of fire prevention, it is rendering a nation-wide service, the value of which cannot be measured in dollars and cents. I should be glad to see our Association affiliate with the N. F. P. A., and it seems to me that it would be wise for our Association to urge all of its members to join the N. F. P. A. and co-operate with it in every way in the great campaign of fire prevention.

Adequate Fire Protection Essential.

If the fire prevention program is to be successful, it will be due in no small measure to the co-operation on the part of the water plant superintendent, and his first duty will be to see that his property is fully equipped to furnish adequate fire protection service. This may require the expenditure of a considerable amount of money, but the value of the adequate fire protection service will far outweigh the fixed charges on the extensions and additions necessary to bring the plant up to a point where it can furnish excellent service. The Committee on Fire Prevention and Engineering Standards of the National Board of Fire Underwriters of New York has made a large number of reports on the water departments of the country, and if their suggestions are carried out these water departments would be in position to furnish excellent service and we would to the fullest extent co-operate in the fire prevention program. During the past fifteen years, the National Board of Fire Underwriters has made several reports on the Indianapolis Water Co's property, and we have found these reports exceedingly valuable in that they have pointed out our weak spots and have guided us in mapping out our future extensions and additions. Our company is making a conscientious effort to comply with all of their suggestions, and it is our opinion that the increased efficiency of our water service has justified our expenditures. On a number of occasions they have modified some of their requests or requirements after getting our viewpoint, and in all of our dealings with the representatives of this organization, we have found them broad-minded and fair. I trust that there may be the finest spirit of co-operation between all of our members and the National Board of Fire Underwriters, to the end that the water plants over the United States may furnish a thoroughly satisfactory fire protection service. A high fire loss in a city raises a question as to the integrity of the water plant to the same degree that a high typhoid rate raises a question in the minds of the people as to the purity of the water supply. These assumptions on the part of the public are not entirely true but nevertheless they exist in the minds of many of our citizens. Years of patient effort have largely eliminated typhoid fever, and the same patient effort will eliminate our preventable fires.

Campaign in Indianapolis.

The up-to-date waterworks official made every effort to eliminate typhoid, and he should work just as hard to-

ward the elimination of preventable fires. If a fire prevention campaign has been inaugurated in his city, he should co-operate with it; if none has been inaugurated, he should initiate one and do his utmost to carry it through to a successful conclusion. Acting on this assumption, and on the invitation of W. J. Curran of the Indianapolis Salvage Corps, and E. M. Sellers, Manager of the Indiana Inspection Bureau, the writer suggested to the Indianapolis Chamber of Commerce the formation of a Fire Prevention Committee. This was done in the early part of April, 1921, and the writer was made Chairman of a Fire Prevention Committee consisting of about 1,200 Indianapolis citizens. At the outset, we made a most careful study of our fire loss and were amazed to find that it had increased from a per capita loss of \$1.75 in 1910 to a per capita loss of \$5.10 for the year 1920, and that the average Indianapolis citizen had increased his careless habits in a greater ratio than the city had been able to increase its fire fighting facilities. Our investigation showed that in the year 1910 our city had 5.8 fires per thousand population, and that this had increased to 10.7 fires per thousand population during the year 1920. After going into the matter with great care, we determined that this great fire loss could not be checked by any campaign of one week or one month's duration, and when our campaign was launched we went into it determined to spend four or five years if necessary to achieve the results for which we were working, namely, a cleaner and healthier Indianapolis with an exceptionally low fire loss.

Value of Co-operation.

We realized that the success of our undertaking depended almost entirely upon the one word "Co-operation," and we have received as fine a spirit of co-operation as has ever been accorded to any city-wide undertaking in the city of Indianapolis. At the outset of the 1921 campaign, the city evidenced its interest by defraying the expenses of the fire prevention campaign, and during the 1921 campaign, and the same will be true of the 1922 campaign. Not one dollar has been put up by anyone who might in any way be interested from an ulterior motive. The fire department, and in fact all city departments, have co-operated in an exceptionally fine way and have done their utmost in the cause of fire prevention. No finer service has been rendered by any one than that rendered by the public and parochial schools, and a large measure of the success of our campaign has been due to the exceptionally fine co-operation accorded by these organizations.

We are arranging to conduct a City Beautification Campaign on the theory that if we can replace a rubbish pile with a flower bed or vegetable garden, there will not be much liability of another rubbish pile growing on or near that place. In other words, we hope to make a geranium or tomato grow where rubbish formerly flourished. We are availing ourselves of the services of the Park Department, City Planning Commission, Board of Sanitary Commissioners, and in fact, all City Departments having to do with the general appearance of our city, and the foundation is being laid for a city-wide effort which should, within the near future, make our city one of the beauty spots of the country. In the Fall, we will have a clean-up campaign and a campaign of education in regard to fire prevention measures, and this will be followed up by a "No Accident; No Fire Week" in November.

Our Committees on Laws and Ordinances is giving careful attention to the preparation of a city ordinance making rigid provisions for the elimination of the shingle roof, and is also preparing a bill for the presentation to the next Legislature covering Personal Liability for Preventable Fires. We are just beginning to realize the length and breadth of a fire prevention program, and our experience indicates that it achieves the following results for a city:

1. Makes for better health conditions through the instrumentality of Clean-Up programs.
2. Decreases fire loss.
3. Decreases the loss of life due to fire.

4. Is essentially a Safety First Campaign.
5. Makes a City Beautiful through the elimination of rubbish piles, dilapidated buildings and other fire hazards; and
6. Makes better American citizens.

Our neighboring city, Cincinnati, has achieved wonderful results through the instrumentality of its Fire Prevention Campaign, which has been waged unremittingly for the past several years, their records showing a reduction in fire loss of more than one and one-half million dollars a year; a reduction of 20 fire houses, with a consequent reduction in taxes and an insurance rate which is said to be the lowest in the United States. What Cincinnati has done, Indianapolis can do, and what we can do every American city can do.

Resolutions.

In order to get this matter before the Association in concrete form, I desire to present the following preambles and resolutions and move their adoption:

WHEREAS, America's fire loss has reached the proportions of a national calamity and as a nation we are becoming criminally careless; and

WHEREAS, The United States and Canada are suffering from economical impoverishment due to excessive annual losses of their created and natural resources from preventable fires; and

WHEREAS, Proper fire prevention and extinguishment is a subject closely related to and affecting the competent conduct of the waterworks systems of the states, provinces and municipalities of these countries:

IT IS THEREFORE RESOLVED, That the American Water Works Association pledges its active interest in furthering and participating in all proper efforts to reduce the fire losses of these countries and calls upon its members actively to initiate, assist and encourage in their various localities movements to this end.

I would further move that the American Water Works Association affiliate with the National Fire Protection Association and that effort be made to induce our members to join the National Fire Protection Association.

I would further move that the American Water Works Association call upon all of its members to comply with all reasonable regulations and requirements of the National Board of Fire Underwriters to the end that their water plants may furnish adequate fire protection service, and I would further move that the American Water Works Association use its every effort to bring about the enactment of laws covering Personal Liability for Preventable Fires.

LARGE CONTRACT FOR WELLAND CANAL.

TENDERS are being called for the completion of sections 3 and 4 of the new Welland Ship Canal, by the Department of Railways and Canals. Tenders close June 9. These two sections comprise the heaviest portion of the work yet to be done, running as they do through solid rock, and include the erection of locks 4, 5, 6 and 7, of which locks 6 and 5 are twin in flight. The estimated value of the contract is thirty million dollars, and the whole of the work has to be completed by March 31, 1926. The locks on this section are the largest locks in the world, equalling an ascent of 139½ ft. Each lock is 800 ft. long, with 28 ft. of water on sills. It is estimated that there are about four million cu. yds. of rock and twenty-six million yds. of earth to be excavated on this section, and about one million five hundred thousand cubic yards of concrete to be laid.

The specifications call for the successful tenderers to purchase all the plant and equipment now owned by the government on the sections, valued at \$2,500,000, thus making the contract the largest ever awarded in Canada calling for the expenditure of thirty million dollars for

work to be done and for the contractor to pay two and a half million dollars for the purchase of the plant.

These two sections run through the town of Thorold. Since 1919 they have been working on the cost plus system of contract. Doheny, Quinlan and Robertson being the contractors, but the government now desire to revert to the unit price contract. Alex. J. Grant is the engineer in charge of the whole canal, while F. S. Lazier is the divisional engineer for sections 3 and 4.

REGULATIONS COVERING SPEED, ETC. OF MOTOR TRUCKS.

AT the National Highway Traffic Association convention held on May 12 in New York City, a report was presented by the National Committee on "Regulations Covering Speeds, Weights and Dimensions of Motor Trucks." The Committee unanimously decided on the following extreme dimensions for motor trucks: width, 96 in.; height, 12 ft. 6 in.; length 30 ft. The maximum axle loading to be 22,000 lbs., and for solid rubber tires 800 lbs. per inch of tire width measured at the base of the rubber.

There still exists a diversity of opinion among the members of the committee as to the maximum permissible weight per vehicle, the highway engineering members refusing to approve the 28,000 lb. maximum which was the consensus of opinion of the balance of the committee. At the last annual convention of the Association in April 1921, this question was referred to the members there assembled, and the convention by a large majority approved the 28,000 lb. limit, the highway engineering members still votely adversely.

The following speeds were adopted:

Gross Weight, lbs.	Country.	City
4,000	25 miles	20 miles
8,000	20 miles	20 miles
12,000	20 miles	15 miles
16,000	15 miles	15 miles
20,000	15 miles	15 miles
24,000	15 miles	15 miles
28,000	15 miles	15 miles

We still consider that there is insufficient data available on the use of pneumatic truck tires to enable us to make any definite recommendations concerning them further than to say that, the use of pneumatics seems to reduce the force of impact on the road surfaces to a certain degree, and also that, experiments seem to indicate that they cause fully as much wear on hard surfaced roads as do the solid tires, and even more wear on gravel and certain forms of macadam.

The only trailers that should be permitted to operate through congested regions, would be so constructed that they would have no tendency to weave from side to side.

Laws concerning the number of trailers which would be permitted behind one tractor, should be sufficiently elastic to limit the number to one, where traffic congestion is great, and to permit more than one where such congestion does not exist.

SPECIFICATIONS FOR REFRACTORIES.

AT the last meeting of the advisory committee of the U. S. Bureau of Standards, on specifications for refractories, it became evident that additional investigation would be necessary to determine what test requirements are most effective in drawing the line between satisfactory and unsatisfactory brick for furnace linings in stoker fired boilers. As a result preparations are being made to conduct an extended series of tests, including a 72-hour reheating test at 1450 deg. C. A prominent consulting engineer is co-operating with the Bureau in this work and in addition to gathering information as to the suitability of different brands of brick, is arranging to have a quantity of samples representing about 20 brands shipped to the Bureau of Standards by the users.

ANALYSIS OF PRESENT HIGHWAY TRAFFIC*

Benefits from Increase in Motor Traffic — Registration Heavier — Effect of Heavy Trucks on Road Surface — Two and Three Ton Units Are Economical Sizes.

By John H. Mullen,

Chief Engineer, Minnesota Highway Department.

WITHIN less than fifteen years a complete revolution of highway transportation has taken place, changing within that period from horse drawn to almost entirely motor driven traffic. On account of small percentage of horse drawn vehicles we are now inclined to eliminate them from consideration as a governing factor in traffic studies, but as an obstacle to speed and consequently as a limitation on the volume which may be carried over a congested line, this traffic is of importance and calls for thought on the part of highway engineers, to provide some relief such as slow traffic lanes along the sides of heavy traffic roads. Most of the road pavements in the United States have been built to a width of 16 to 18 ft. and generally without shoulders adequate to carry a line of slow moving traffic. The result is that when one of these roads carrying from 30 to 50 horse drawn vehicles acquires a traffic of over 1,500 vehicles per day there is congestion, decrease of speed and danger of collision on account of difficulty in passing. The decrease in horse drawn as a percentage of the total traffic has been very rapid, but this does not mean that the volume of horse traffic has decreased in like proportion. On the contrary on many main roads it has remained practically constant and in some instances has increased. As a typical example, the average daily traffic count for the four past years on one of the main roads in Minnesota, show horse drawn in the following number of vehicles, i.e. 17, 33, 35 and 38 per day, a reasonably constant number, while the same road for the same years showed motor vehicles to the number of 440, 501, 883 and 1,230 respectively. This situation would not exist on roads connecting contiguous industrial centres but will be found to be fairly general in agricultural communities, particularly where farms are small and horses are required for other farm work. In other words, throughout the United States, horse drawn traffic will have to be reckoned with as a minor element in highway transportation for many years.

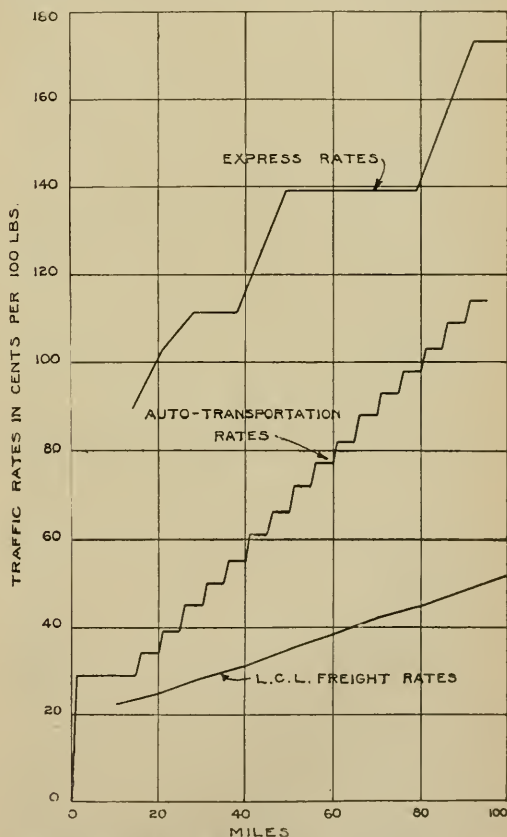
Motor Trucks Develop Trade.

The remarkable increase in the number of motor vehicles in use in this country, has brought many benefits. As a business proposition, the motor vehicle has increased the trade radius of the merchants and has made accessible for dairying and quick marketing great areas of land which could formerly be utilized only for grains and staple crops. It has also made possible the de-centralization of smaller industries formerly confined to restricted districts on account of slow trucking, but which are now enabled to locate in suburban territory. It is predicted that with the improvement of roads this latter condition will be developed to an extent that will greatly improve the living conditions of industrial workers. The motor vehicle is revolutionizing the social life of the country. Formerly the general travel radius on roads did not exceed ten miles and the visiting radius in rural districts was two or three miles. The trip to town was a weekly affair taking a whole uncomfortable day. Rarely was there any visiting between towns or to different parts of the country excepting on railroad excursions. But with the advent of the motor vehicle the travel radius on highways has been greatly extended and is limited only to the conditions of the roads. We find in the lake regions of Minnesota during the Summer, cars from nearly every state in the Union; the census at 137 stations in the State during 1921 showing an average daily traffic of 565 cars of which 59 or more than 10% were from other states. It is reasonable to assume that not less

than another 25% were from other counties within the State, which at an average of three people per car mean at least 600 outside visitors per day passing each recording station. Practically every farmer now has an automobile and in the rural districts of the Middle West. One of the greatest benefits is through the consolidation of rural school districts made possible by motor transportation, which is giving to the farm children throughout the country the advantage of graded schools without having to move to the cities. All of this is giving us a broader view of life and creating better general conditions, but at the same time is increasing traffic on the highways, which requires extensive programs of road construction and maintenance.

Remarkable Increase in Registration.

From such records as are obtainable, it appears that the increase in motor traffic is very nearly in the ratio of increase of motor vehicle registration. This increase in the United States, follows a rapidly rising curve, starting at 48,000 vehicles in 1906, running to 500,000 in 1910 and 2,423,788 in 1915. From 1915 to 1920 the increase is practically uniform at the rate of about 1,300,000 vehicles



COMPARISON OF FIRST CLASS L. C. L. FREIGHT RATES — EXPRESS RATES AND AUTO TRANSPORTATION RATES

per year, with a total registration January 1, 1920, of 7,523,664. During 1920 there was an increase of 1,754,697, making a total registration on January 1, 1921, of 9,278,361. Registration for the first six months of 1921, as reported in "Public Roads" is 9,245,195, a decrease of 33,166, which would indicate a considerable falling off in

*Paper read at the annual meeting of the American Association of State Highway Officials, Omaha, Neb.

the ratio of increase of cars this year. This is to be expected, for it is estimated that the number of cars in proportion to population is approaching a reasonable maximum. In 1915 there were in the United States 42 persons per car, in 1919, 14 per car and in 1920, 11 persons per car. The 1920 figures range from a maximum of 31 persons per car in one of the southern states, to 5 and 6 in well developed agricultural sections, with 12 to 14 persons per car in the industrial sections where roads are practically all improved. It may safely be predicted that the number of automobiles will not exceed one to five people in the agricultural sections and one to ten people in the industrial sections of the country, even under the most prosperous condition, with the probability that there may be a falling off in ratio during times of depression, for it must be admitted that prosperity has a considerable bearing upon the number of passenger cars in the country.

Seasonal variation in traffic as shown by records would indicate that probably 25 to 35% of that on the main lines is regular and may be classed as business or necessary traffic. This traffic will continue to use those main lines and would not be diverted by improvement of parallel roads, but the balance which may be classed as convenience or pleasure traffic will in part seek other routes when the main lines become congested. This leads one to believe that a considerable portion of the traffic will be taken care of by parallel roads, and excepting for suburban roads and routes physically confined to one line between centres, the volume will not greatly increase on the present heavily travelled roads, but will be spread more uniformly over parallel routes.

Commercial traffic, including trucks and passenger busses presents the most difficult problem for solution by the highway officials. This class of traffic has had a marvelous development within a very few years, but this development cannot be accurately estimated for the reason that many of the States do not have a separate registration for trucks, and traffic counts are scattering and not uniform enough to allow for tabulation. It is estimated that there were approximately 988,000 trucks and commercial cars registered for the year 1920, or slightly over ten per cent. of the total motor vehicles. That the trucks are confined more to cities and do not use the rural highways in proportion that automobiles do except in industrial sections, is evident from observation and traffic counts, but it is also very evident that the ratio of increase in the number using the roads is greater. For example, traffic counts taken at the same stations on State roads in Minnesota show daily averages for 1917 of 463 automobiles and 8 trucks, while for 1921 the average are 1,099 automobiles and 72 trucks. Reduced to percentage the increase in autos is 23% while the increase in trucks is 900%. These figures are taken on roads which were not substantially changed as to surface and the increase is not due to paving or other influence authority for the statement that practically the same situation exists in eastern States but of course in much greater volume, and cities had surfaced roads in Rhode Island upon which automobile traffic increased 162% in the past six years while the truck traffic increased 659%. The percentage of trucks to total traffic is also comparable in both of these cases. In Minnesota the increase being from 1% to 6 1/2% in five years, and in Rhode Island from 3% to 15% in six years. An abstract from the traffic counts made throughout the country indicates that practically the development of trucking. Professor Blanchard is of the same ratio of increase prevails and that the ratio of trucks to cars comes within the range of percentages above stated, which is an indication that we should figure the main arterial highways to carry truck traffic in the amount of about 10% of the total, running up to 20% or better on main arteries connecting centers within fifty miles of each other, and not less than 5% on what might be termed passenger trails.

Heavy Trucks in Minority.

Observation on the kinds of truck traffic are interesting, and contrary to the general impression we find that

the heavy truck is very much in the minority and with the usual exception of roads connecting contiguous cities, the five ton truck does not average more than 10% of the total truck traffic, while 75% of the trucks are two tons and less. It is to be expected that truck routes up to 50 miles in length will have an increasing number of five ton or larger trucks, but up to the present time and in the near future the bulk of the traffic is what may be termed express rather than freight and can be hauled more economically in the lighter trucks. Furthermore, one of the considerations in selecting truck service in preference to railroad service is speed and the convenience in the pick up and distribution of loads, which are points in favor of the lighter truck. A bulletin was recently issued by the Department of Agriculture dealing with motor trucks on farms, in which it is stated that on a survey of 753 farms in the eastern states it is found that farmers own trucks of all sizes ranging from 1/2 to 5 ton capacity, but that nearly half of the trucks used on farms are of the one ton size with only 3% of the owners recommending trucks of over two ton capacity. The same condition is found to exist in the Middle West where farmers at a considerable distance from railroad stations are using trucks quite extensively and in practically all cases are selecting trucks of two ton or less on pneumatic tires. The extent to which this traffic may grow is dependent almost entirely upon the improvement and systematic maintenance of roads, for a steady traffic of 20 trucks per day regardless of weather conditions, is more injurious to an earth or gravel road than automobile traffic averaging 300 cars per day.

Commercial trucking of commodities outside of cities has developed somewhat blindly and it is found that this service has not been generally profitable to the truck owner except where the entire length of the route traversed is hard surfaced. As an example, a terminal truck service was established three years ago at the Twin Cities in Minnesota and in the second year 25 companies were operating through this agency over all kinds of roads. Of this number, seven have discontinued business on account of poor sections of road on their routes, the remaining eighteen companies are continuing to do business in a more or less profitable way dependent upon the proportion of good roads on the lines they cover. This service has been conducted practically the same as railroad service with regular tariff sheets for the various lines and with cargo insurance in all cases. An attempt was made to work on a schedule but this was found practically impossible on account of weather conditions and unfinished sections of road which prevented hauling at certain times.

Lighter Trucks More Popular

The interesting features to engineers in analyzing this service is that the trucking companies find two and three ton units on pneumatic tires to be the economical size. A chart of the rates as compared with first class L.C.L. freight rates and first class express rates shows that the auto transportation rates while about 100% above the freight rate is only 50% of the express on the short haul but for the longer haul the ratio of difference between freight and auto increases, and between auto and express decreases, showing that the unrestricted use of public highways for commercial trucking works very much to the disadvantage of railroad express business for distances up to about 100 miles, but for short haul freight, when taking into account the terminal trucking, the auto transportation will relieve the railroads of what they have always claimed to be an unprofitable business and this at a decreased cost to the public. In this connection it is interesting to note the reported statement of officials of a railroad company in New England that the railroad loses one million dollars a year in freight revenue on the shoe industry alone as a direct result of motor truck competition and that some of the small branch lines in the industrial sections of New England have been abandoned by reason of their inability to meet motor truck competition.

So far as traffic is concerned motor bus service may be included as trucking, for most of the busses are two-

ton high speed trucks. This bus service is becoming general throughout the country and is conducted profitably during favorable weather at rates slightly less than railroad passenger rates. We find however, that there is a decided falling off in the motor passenger business during bad weather and in the Winter. Continuous bus service is only established on long sections of surfaced roads, and with the paving or even gravelling of connecting lines of travel we may expect a substantial development of this traffic with its consequent effect upon the railroad passenger business.

Motor Vehicle Taxes

It is very evident that in fairness to the tax paying public and the railroads, there must be a State supervision of commercial use of the highways, and that gross earnings taxes should be imposed for this privilege, or at least that more equitable motor vehicle taxes be fixed for such use of the roads with all revenue made available for road purposes. It is only reasonable that commercial traffic should carry its share of road expense and that the State should prohibit the commercial hauling of passengers or commodities on public highways except by responsible concerns bonded and supervised by the State.

As stated with reference to horse drawn traffic, the volume which a given road may carry is governed very largely by the manner in which traffic is handled. Practically all State laws now prescribe a maximum speed limit of 25 miles per hour with no reference to minimum speed. To properly handle traffic the maximum on heavy passenger lines should be increased to 40 miles per hour for certain hours of the day, with a requirement that traffic must stop on the intersecting lines before crossing or entering the main lines and there should be a minimum speed limit on main lines of 25 miles per hour during those hours. It will be found that roads which now appear to be congested will very easily handle their traffic within these limits, and there is no reason why the minimum rate should not be imposed for at least a 12 hour period from about 8 in the morning until the same hour in the evening. This will take care of the peak load of passenger and light express business and will cause the slow heavy trucking to be handled during the night time when there will be no interference on either side. This and other effective traffic regulation calls for a state system of traffic police, the value and efficiency of which has been well demonstrated in the State of Pennsylvania.

Economical Limit of Weight.

Highway engineers and most truck manufacturers are practically agreed upon an economical limit of weight of vehicles and wheel loads for public highways. This is expressed in the proposed uniform traffic law adopted by the American Association of State Highway Officials and which has been incorporated in the highway laws of several of the States, but in all localities we find an occasional trucking company or truck manufacturer using excessively heavy vehicles. If this were allowed to continue the public would be called upon for an unwarranted expense to rebuild roads destroyed by that small portion of traffic and it is therefore extremely important that a uniform limit be established throughout all of the States and this limit should be well within the maximum prescribed in the proposed traffic law.

In making a study of highway traffic one is impressed by the lack of definite comprehensive information on the subject and the conclusion is that in every highway department there should be an engineer assigned to traffic surveys. These surveys to be made in a somewhat uniform manner in all of the States and the results compiled for the whole country by the government Bureau of Public Roads. The highway departments are not organized primarily for the purpose of moving dirt and building pavements, but in performing their real function in the development of the country they are in fact great traffic departments designed to provide means of carrying the tremendous volume of highway transportation and to properly do this work, the systematic study of highway traffic is essential.

CAISSON DISEASE BECOMING LESS DEADLY.

HEALTH hazards which at one time were regarded as inherent in the occupation of shaft sinking and tunneling under the high air pressures necessary to keep back the water in wet ground and quicksand, have been greatly reduced according to the United States Bureau of Mines. Observations made by Dr. Edward Levy, consulting physiologist of the Bureau, during the progress of tunnel work in and about New York City, indicate that the methods employed there have become so systematized and improved as almost to eliminate severe or fatal cases of compressed-air illness. The results of physiological studies made by the Bureau of Mines in the depths of its experimental coal mine at Bruceton, Pa., will be utilized in the construction of the vehicular tunnels to be built under the Hudson River between New York City and New Jersey and in the twin vehicular tunnels now under construction at Pittsburgh, Pa.

Compressed-air work has assumed a place of enormous economic importance in modern engineering. Frequently deep-mining operations, subaqueous tunneling, and bridge building can be conducted only by the aid of compressed air. The construction of underwater tunnels or "tubes," the principal means of intercommunication between such large business centres as Manhattan Island and Brooklyn, would be impossible without it. The prosecution of these various activities requires the employment of numbers of men who work under varying degrees of air pressure. The effect of compressed air upon the life, health, and efficiency of workers becomes, therefore, of increasing importance in the study of occupational diseases and the medical problems of industries. No thorough research has been done in this field in the United States. Knowledge of the cause, character, and treatment of compressed-air illness is still limited to a very few physicians, and thus far little interest in the subject has been evinced by the medical profession at large.

Cause of Disease.

Caisson disease, compressed-air illness, or, more properly speaking air embolism, is a condition caused by a too rapid decompression after exposure to higher pressures for a period of time. The symptoms of compressed-air illness are vertigo, difficult breathing, localized pains, affections of the central nervous system, and unconsciousness or collapse. The formation of gas bubbles of nitrogen in the body fluids and tissues is the accepted theory at present of the cause of caisson disease.

In an employment so hazardous as that of a "sand hog" some attention should be paid to the class of men best fitted for it, the Bureau of Mines declares. Actual experience has led to the conclusion that in the selection of men the essentials are normal lungs, normal kidneys, and a good heart; in the older men the blood pressure must not be high. In the selection of workmen for compressed-air operations, the Bureau is not sure that advanced age is quite the important factor that many writers have insisted; neither is it considered that fleshy men are unduly susceptible to compressed-air illness.

Treatment by Recompression.

Long before any great American projects requiring the use of compressed air were undertaken it was recognized that recompression was the correct treatment for compressed-air illness. A worker suffering from compressed-air illness should be put in a medical lock and the pressure rapidly raised to that in which he had previously worked. It is a good policy to keep the patient at this pressure for a short time in order to be sure that the bubbles of nitrogen have been thoroughly compressed and again taken up by the circulation. The patient may then be decompressed again by the stage method, except that now the time should be double in every part of the decompression. Although symptoms are frequently relieved before the pressure in which the men had worked is reached, it is safer to attain the original pressure before decompressing.

TRAFFIC CAPACITY AND WIDTHS OF HIGHWAYS OUTSIDE MUNICIPALITIES*

Functions of Roadway Affecting Width—Investigation Into Traffic Speeds—Roadway Widths and Safety of Traffic.

THERE has been a large quantity of statistical data compiled throughout the country in the nature of a traffic census and many traffic studies have been made to determine the future traffic for given highways. Most of such data is not of maximum value, however, in determining the desirable width of roadways for a given traffic, in as much as the variation in speeds of various classes of vehicles generally is not given consideration. Any computation of required width of roadway based upon the assumption that all the traffic on a given highway outside of a municipality will travel at a common speed should be used with great reserve as the assumption is obviously incorrect in all but exceptional cases.

For the greater part, highways outside of municipalities need have but two lanes of traffic to care for the traffic which they are called upon to accommodate. Highways leading into large municipalities or connecting nearby cities, however, present a problem that calls for careful solution in as much as they may and often do carry traffic that varies in speed from about three miles per hour to thirty-five miles per hour. In many cases the quantity of traffic approaches and often exceeds, the economical traffic capacity of a two lane roadway, although computations may show that the amount of traffic anticipated from traffic surveys could be carried adequately by a two lane roadway if the traffic is assumed to travel at a common uniform and properly selected speed.

Factors Controlling Width.

In cases of highways which are to carry congested traffic, the designing engineer must give careful consideration to all functions of a roadway which should affect his decision in choosing the number of lanes of traffic to be required and the modification of widths of roadways and shoulders for any given number of lanes. The functions of a roadway which thus affect the design of its width are enumerated as follows:

1. To provide a sufficient number of lanes to carry the traffic that comes upon it.
2. To provide means of allowing fast moving vehicles to pass vehicles moving more slowly, the speeds being within legal and operating limits.
3. To provide for the ranking of vehicles at the roadside in such cases as for necessary temporary repairs.
4. To be of such a width as to discourage the taking of dangerous chances by operators of vehicles.

When a two lane roadway has become so congested that it is impossible to operate a vehicle without considerable loss of time due to traffic delay, its economic traffic capacity has been exceeded. This degree of congestion occurs for a traffic count of a great deal less than that equal to the computed traffic capacity of the roadway when variation in speed is not considered. As the amount of traffic or speed variations increase, the possibility of passing a slowly moving vehicle when it is overtaken becomes less. Ultimately, it becomes entirely impossible for vehicles to pass each other and all traffic must assume the speed of the slowest moving vehicle.

To emphasize the relation that should exist between traffic and roadway widths, the results of office computations and field observations of traffic operation made* by the chairman of the committee may be of interest.

Variation in Speeds.

For one typical series of investigations for a two lane roadway, a traffic of 750 vehicles per hour was assumed,

500 of which travelled in one direction, the remainder travelling in opposite direction. Three assumptions as to variation in speeds were made.

- First; 3 percent were assumed to travel at 3 miles per hour, 10 percent at 10 miles per hour, 57 percent at 20 miles per hour and 30 percent at 30 miles per hour.
- Second; 13 percent were assumed to travel at 10 miles per hour, 57 percent at 20 miles per hour and 30 percent at 30 miles per hour.
- Third; 13 percent were assumed to travel at 10 miles per hour and 87 percent at 20 miles per hour.

It was found that under the first assumption that the meeting of two of the 3 mile-per-hour vehicles slowed down traffic each way along the road for a distance of one quarter mile. The meeting of vehicles of various faster speeds affected the movement of traffic similarly but to a less degree. It was also evident that 750 vehicles per hour, two thirds of which are travelling in one direction and under the first outlined assumption as to variation in speeds, could not be operated on a two lane roadway.

Under the second assumption of speeds, the meeting of two slow vehicles affected the traffic for a distance each way along the road of 300 feet, and the operation of the traffic under this assumption was entirely possible.

Under the third assumption the traffic was shown to operate smoothly and the quantity could have been considerably increased.

The foregoing results should be compared with computations based upon the assumption that all vehicles will travel at a common speed. Under logical assumptions as to clearance between vehicles, and assuming that all vehicles will travel 15 miles per hour, a two lane roadway should carry about 2600 vehicles per hour in each direction. If the speed is reduced to 3 miles per hour by a few heavy horse drawn vehicles, the capacity is reduced to about 750 vehicles per hour in each direction. There can be no doubt, therefore, that the variation in speeds affect the traffic capacity and hence the required width of a roadway.

Quite obviously, a stalled car which, through inadequacy of shoulder design, is prevented from pulling to one side and hence blocks one lane of traffic, has the same or a worse effect on the traffic capacity of a roadway than a slowly moving vehicle. The roadway traffic capacity can be materially increased by adequate width and design of shoulders.

The safety of traffic should not be disregarded in the design of roadway widths. In the case of a two or four lane roadway, every vehicle operator realizes just when he has the right of way and when he has not. The operation of a three lane roadway, however, is not so simple. The centre lane is not and cannot be reserved for traffic in either direction, so it must be left to each individual operator to decide whether he is more entitled to this lane than another operator going in the opposite direction. Such a width of design fosters danger to traffic.

Conclusions for Consideration.

The following tentative conclusions were submitted for consideration.

1. The design of roadway widths must give consideration to the economically desirable variation in speeds of the various classes of traffic.
2. Any two lane roadway carrying intensive traffic should have a width of 20 ft. and should have 5 ft. shoulders capable of sustaining standing vehicles for temporary delays.
3. A two lane roadway should be increased to a four lane roadway when the traffic is reduced to the speed of the slower vehicles through not being able to pass, if the economic loss of time will justify the expense.
4. The building of three lane roadways should be discouraged due to the danger to the travelling public.

*Report of National Committee presented at National Highway Traffic Association Meeting, New York City, May 12.

PROTECTION OF PILES BY GUNITE.

Encasement of 2 in. of Reinforced Concrete Resists Marine Organisms — Piles Withstand Driving and Rough Handling Without Damage.

AMONGST the many methods proposed for protecting wooden piles from the ravages of marine organisms, one of the most promising is the coating of the pile by gunite. While engineers have been satisfied for some time that a mortar coating of perhaps 2 in. would be sufficient to afford the required protection, the problem of so reinforcing this protecting shell that the pile might be driven without breaking the shell has required careful study.

In this connection the experience of the engineering staff of the Port of Tacoma, Washington, is of value. A total of 1442 piles representing a total length of 78,237 ft. were driven in the Tacoma work with results that are said to be uniformly excellent.

To ensure that the proposed protection would stand the driving, two test piles of the form indicated in Fig. 1 (a) were driven. The first pile was driven without the use of a jet, the hammer weighing 4,500 lb. and the drop being 5 ft. No cushion was used between the pile and the hammer. On the 45th blow the gunite began to show

appears to have been satisfactory in work undertaken elsewhere. Thus, the piling for a trestle built by the Puget Sound Power and Light Co. done in recent years was thoroughly examined in the autumn of 1921 and found to be in excellent condition. The Freeport Sulphur Co., of Freeport, Texas, drove, in 1920, a total of 87 piles 50 to 60 ft. long encased with gunite approximately 25 ft. each, that is for the portion of the pile between the mud line and the water surface. The gunite coating was not injured in driving and the protection against the teredo has been entirely satisfactory.

ENGINEERING INSTITUTE ELECTIONS

At a meeting of the Council of the Engineering Institute of Canada, held on May 22 in Montreal, the following elections and transfers were announced:

Members—J. R. Atkins, Ottawa; L. F. Goodwin, Kingston; F. Y. Harcourt, Port Arthur; L. C. Hill, Montreal; J. D. Jones, Sault Ste. Marie; J. H. G. Marshall, Ottawa; W. W. Meadows, Maple Creek, Sask.; A. H. Morgan, London; Thomas Shanks, Ottawa; J. H. Turner, Coalhurst, Alta.; G. G. Underhill, Montreal; B. W. Waugh, Ottawa.

Associate Members—H. J. Clark, Belleville; W. P. Dale, Niagara Falls, Ont.; H. M. Fletcher, Hamilton; R.

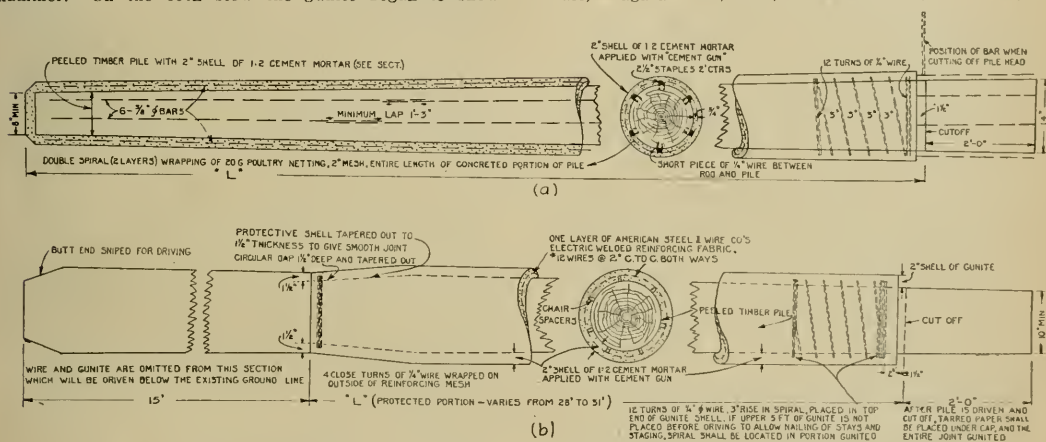


FIG. 1—TYPES OF PROTECTED PILES USED IN HARBOR WORK BY PORT OF TACOMA, WASH.

small cracks, whereupon the hammer was raised so as to give a fall of 15 ft. with the idea of wrecking the pile. This was not accomplished until the 75th blow occurred, when large cracks opened up in the gunite in line with the 3/4-in. vertical rods.

The second pile tested was constructed also according to Fig. 1 (a). This was first jetted into place with the point down, then pulled up and jetted into place butt down, with no damage to the gunite after these two operations. The pile was also treated very roughly, that is, it was picked up with a line attached to one end, thus resolving the pile in a single span subjected to bending due to its own weight and to the shock of handling.

In view of the results of this test, it was decided to discontinue the use of the vertical rods and of the poultry netting, and use one wrapping of American Wire & Steel Co's welded fabric with No. 12 gauge wire at 12 in. centres both ways, as shown in Fig. 1 (b).

The new form of pile devised for the Tacoma work is shown in Fig. 1 (b). It is proposed to drive the piles butt down for the reason that 15 ft. of gunite will be saved in so doing, and the same bearing value will be realized as if the pile had been driven point down and gunite full length. It is assumed that the whole bearing value arises from skin friction.

Experience with wooden piles coated with gunite ap-

J. Fraser, Ottawa; C. H. B. Garland, Ottawa; F. O. Hamel, Ottawa; C. P. Hotchkiss, Ottawa; W. G. Hughson, Ottawa; C. S. Macdonald, Ottawa; T. J. McL. Moore, North Bay; S. J. Murhy, Ottawa; C. C. Planche, Calgary; L. C. Prittie, Ottawa; J. H. Ralph, Ottawa; H. W. Rowley, Coaldale, Alta.; A. E. West, Walkerville.

Juniors—John Drybrough, Toronto; P. L. Kuhring, Ottawa; P. N. Libby, Montreal.

Associates—R. R. Jarvis, Ottawa; David Trainer, Calgary.

Transferred, Associate Members to Members—W. A. Bucke, Toronto; J. G. Cameron, Cornwall; H. S. Carpenter, Regina; A. W. Connor, Toronto; T. H. Hogg, Toronto; A. C. Mackenzie, Montreal; G. D. MacKinnon, Sherbrooke; John Rankin, Ottawa; W. H. Sutherland, Westmont; H. L. Trotter, St. Johns, Que.; W. H. Winterrowd, Montreal.

Transferred, Juniors to Associate Members—W. D. Adams, Toronto; W. W. Crouch, Jr., Mexico, Missouri; R. A. deValter, Quebec; B. A. Johnston, Winnipeg; G. W. F. Johnston, Chatham; Stewart Schofield, Winnipeg.

Transferred, Students to Associate Members—E. R. Grange, Ottawa; W. H. Stark, Niagara Falls, Ont.

Transferred, Students to Juniors—W. L. Campkin, Regina; S. L. Fultz, Halifax; C. E. Malone, Kingston; D. R. Paterson, Galt; Charles Pearson, La Romana, Santa Domingo.

PRESENT DAY TARS FOR PIPE COATINGS*

Dr. Angus Smith's Solution — Standard Specification for Pipe Coatings — Quality of Tar Used at Present Time — Objective for Research Work.

By William R. Conard.

MORE than 70 years ago a process for coating cast iron pipe, using coal tar, was developed by Dr. Angus Smith and this process, or variations of it, have been in practically constant use since for cast iron, and it or coatings with an asphaltum base have been used for wrought iron and steel. For the smaller sizes of wrought pipe galvanizing has also been extensively used, as well as lead lining and cement lining. At the time Dr. Smith invented his process, "coal tar" was a residue from the manufacture of gas from coal, just as it is today, only in those days the many by-products now obtained from this residue were apparently little known, and the tar was in every way what is termed "Virgin Tar". Could the good Doctor have foreseen some things, such as by-products, tar from oil and water gas sets, etc., it is probable that he would have given much more detailed specifications, and placed many safe guards around the coating and process.

Standard Specifications.

The standard specifications for coating pipe are as follows:

Every pipe and special casting shall be coated inside and out with coal-tar pitch varnish. The varnish shall be made from coal tar. To this material sufficient oil shall be added to make a smooth coating, tough and tenacious when cold, and not brittle nor with any tendency to scale off.

Each casting shall be heated to a temperature of 300 deg. Fah, immediately before it is dipped, and shall possess not less than this temperature at the time it is put in the vat. The ovens in which the pipe are heated shall be so arranged that all portions of the pipe shall be heated to an even temperature. Each casting shall remain in the bath at least five minutes.

The varnish shall be heated to a temperature of 300 deg. Fah. (or less if the engineer shall so order), and shall be maintained at this temperature during the time the casting is immersed.

Fresh pitch and oil shall be added when necessary to keep the mixture at the proper consistency, and the vat shall be emptied of its contents and refilled with fresh pitch when deemed necessary by the engineer. After being coated the pipe shall be carefully drained of the surplus varnish. Any pipe or special casting that is to be recoated shall first be thoroughly scraped and cleaned.

This follows somewhat the specifications as first developed by Dr. Smith, but you will immediately note the term "Coal Tar Pitch Varnish." The terms pitch and varnish are used a number of times when as a matter of fact the material is not pitch nor is it varnish as they are generally understood. Pitch is the residue of tar after distilling, or is an extract of "pine tar," and varnish is generally understood as being a resinous product. Another thing the kind or kinds of oil and the proportions are not definitely stated, and in this connection variations in season and weather, and the opinion of individuals, should be offset by definite statement.

Coal Tar.

Average coal tar is made up of carbons, oils, acids and gases. The acids and gases in the forms of hydrogen, oxygen, nitrogen and sulphur. Its main body is carbon and it is the carbon held together by the oils which protects the metal from corrosion, and it is the acids that tend to attack and corrode. Therefore it is desirable to use for pipe coatings a tar as free from acids as possible, and high

in carbon and oils, especially the heavier oils, and to use coating at temperatures that will not evaporate the oils.

Coal tar and the by-products that are being extracted therefrom are put to a wide variety of uses. The heavier material usually called tar (no matter how much it has been distilled or refined) is used for paving, road work, the varying forms of roofing materials, such as paints, etc., while the lighter part is used in many lines of industry particularly in the manufacture of chemicals, so that its value is greater for refining purposes than in its crude state, which condition is the best for pipe coating purposes. The result is that unless the pipe maker controls some source of production, he has to compete with the refiner, with the consequence that there are times when he gets deceived, and the pipe purchaser is the innocent sufferer. This does not mean that the pipe maker is responsible for this, but it is simply due to circumstances.

It will be many years before the supply of bituminous coal from which we get our tar is exhausted, but as the by-products become greater in variety and value, the keener the pipe maker will have to compete, and the greater will become the cost. At present the tar used for pipe coatings is about 15 per cent. of the total cost of coating pipe, but when is the point going to be reached when economy ceases, in using coal tar, and what other material or materials can take its place?

It is not the purpose of this paper to attempt to technically cover the various points that the subject of pipe coatings brings up, but it is the belief of the writer that while the pipe maker specifies and tries to get "virgin tar," that the tar does not contain as large a proportion of the heavy mineral oils as the tars of Dr. Angus Smith's time contained, so that, there are cases where the coating is not as durable as it was formerly. It is the writer's further belief that it is high time that careful and more extended studies, and research should be undertaken to see what might be done about it, and it is entirely within the range of possibility that even using coal tars that have had their by-products extracted together with some other material or materials whether oils or some other form of binder, that a better and more durable coating than is now used can be found. I would not suggest disregarding tar entirely, for there has not yet been found anything that could within economic limits take its place, and I do not think that the virgin tar of today is the last word in pipe coatings, but I do think that thorough research would develop some other material to mix with tar that would form a much better protection to iron and steel pipe surfaces than we are now using.

Research Work.

When we speak of research work it does not mean that investigation has not been made for it has. Dexter Brackett 25 years ago made tests, keeping Thos. Wiggin at the foundries for many months to try and get a better coating. Allen Hazen in 1908-9 had some careful work done. Clarence Goldsmith about 1913, for the Boston high pressure fire service in collaboration with Frank McInnes, tried a variety of tar coatings. The result of Mr. Brackett's and Mr. Wiggin's work in a large measure, is responsible for the specification as at present written. Mr. Goldsmith's work resulted in a specification using tar and rosin, which gave a coating a good appearance but due to the temperatures used, it did not appear to have the lasting qualities required. As a result of his investigations Mr. Hazen favored a tar distilled until the naphtha was removed with enough linseed oil to give a smooth, tough and tenacious coating for steel pipe. As this apparently applies primarily to steel pipe, the writer does not see it mentioned for cast iron, it is rather assumed that the present standard requirements for cast iron are acquiesced in by Mr. Hazen.

Apparently all of these investigators tried other materials, and by a greater or less eliminating process got back to coal tar. At the same time all apparently agree that the various factors such as, heat of the pipe for varying thicknesses, heat of the tar bath and keeping it of known proportions of fresh and old tar, knowing the temperatures,

*Paper read at Annual Meeting of the American Water Works Association, Philadelphia, May 15-19, 1922.

of both pipe and bath and maintaining at predetermined temperatures so as to obtain uniform results, are the prime considerations but all of this as indicated requires men of greater skill and intelligence than the average pipe coater; better, and more extensive apparatus and facilities for doing the work than exist as an average, even at the present time; and after there were attained a very strict adherence to them.

From what the writer has observed of pipe, which have been in service and for some reason taken out, conclusion is that the coating on the pipe is not impervious to moisture, having small pores which usually extend through the coating. This allows the moisture to get to the metal, ferrous oxide forms coming out through these pores, and spreading over the interior of the pipe. Perhaps you may have noticed in pipe taken out that when you take off some of the scales formed that you will find apparently good coating underneath. Therefore while as before stated I do not see that tar should be discarded, research should be made to see whether there is something to use with the tar that will seal the pores, which will prevent the forming of the ferrous oxide, and the formation of tubercles.

You get somewhat the same effect when pipe are allowed to lay out in the weather except that in that case the ferrous oxide begins to form under the coating and causes the coating to scale off. Also I believe that investigation should be made of whether pipe of different sizes and classes should be dipped in the tar bath at different temperatures, for the volume of the metal in the pipe controls the number of heat units to be thrown off before the coating can become set, and as long as the heat prevents the setting of the coating, the heat will also continue to evaporate the oils in the tar and tend to leave nothing but dead pitch.

Materials Used With Tar.

As to what materials might be used in conjunction with tar to prevent the forming of iron oxide, there are three methods that have occurred to me. One is coating the pipe especially the interior with some paraffin substance before applying the tar; this was suggested casually by S. B. Brown of Warren Foundry. Another method is to use some substance that has no oil or gas forming constituent, but in very dense and when set impervious to moisture, which will become fluid at approximately the same temperature as tar, will mix tar readily, and can therefore be put in the tar tank, and applied in conjunction with the tar. And still another might be to find some means of getting a much thicker coating on the pipe, which would stay put, and not tend to scale in cold weather, or soften and run in hot weather. The City of Philadelphia had, and I think, still has a specification stating that the coating shall be at least 1/64 in. thick, which would help to some extent but I do not think is thick enough, and with the existing methods in vogue at the foundries, and the tars used, is quite difficult of attainment.

If simply tars are to be used every known constituent should be determined and careful experiments made in an endeavor to determine which are beneficial and which harmful to pipe as a coating; just which will give the longest efficient life.

Summary.

Apparently present day virgin tars do not appear to contain as great an amount of the heavy oils as the old tars, and probably have more of the lighter oils which evaporate more readily.

Present day specifications are at variance with the process developed by Dr. Smith, and the demands of the pipe purchasers on the manufacturer have been such that the old Smith method, which was a rather lengthy operation and involved dipping the pipe cold in hot tar and allowing them to stay in the bath until the pipe became hot, could not be worked today unless much more elaborate apparatus than that of Dr. Smith's time were installed and

this would be necessary to coat the present amount of pipe produced.

Research if undertaken should be along at least these two lines:

The apparatus necessary to care for the present day volume of production, going back to a strict adherence to the Dr. Angus Smith process or:

Using present apparatus and methods, or something similar in rate of working, and find something to mix with the cheaper distilled tars to get a coating that will be as lasting and protective or if possible more so, than the old Smith process.

THE RAILROAD AS AN OPERATOR OF HIGHWAY TRANSPORT*

Highways Used as Feeders For Railroads Where They Can Utilize Motor Transport — Railways in Great Britain Use Highways for Transport

By Arthur H. Blanchard,

Professor of Highway Engineering, University of Michigan.

ONE of the objects of the National Highway Traffic Association is to develop the economic efficiency of highway transport. This Association, which is independent in its findings, and composed of all classes of men interested in highway transport and traffic regulations, should look into the future and endeavor to formulate guiding principles and policies which will enable the highway link in our transportation system to be developed on a sound business basis in the interests of the public welfare.

What is the present attitude of railroad officials in the United States towards the development of highway transport? The answer is not a simple one to formulate as many diverse opinions have been expressed in words and actions. Some of our railroad officials appreciate the intrinsic value of highway transport and have made use of it as a part of their own transportation systems. Others have advocated its development because they appreciate that it is necessary to the success of their business that facilities should be provided for economically transporting goods over highways to be later carried by railways. Others have been concerned regarding the development of highway transport from the standpoint of destructive competition with railroad transportation and have endeavored to curtail its development through legislative action. Others, and it is hoped that there are only a few in this class, have considered the subject from such a narrow viewpoint that they have advocated a curtailment of highway improvement.

The railroads can render valuable service to the public and to themselves by helping to develop highway transport as feeders to rail lines and as extensions of rail service. The railroads can afford to assist in the working out of this problem as some of the basis principles of the economical utilization of highway transport will have been solved only when highway transports service is used to efficiently expand the territory tributary to the railroad lines, to solve the terminal congestion problem, and to relieve car shortage by taking care of the short haul which is now most expensive for the rail lines themselves. A correct and immediate solution of the inter-relationship between these two links of our national distribution system is very desirable in the interests of all concerned. By no means can the railroads afford to ignore the interest they have in the efficient establishment of highway transport as an auxiliary to railroad transportation.

Opportunities For Railroads.

What are the opportunities for the railroad to function as an operator of highway transport?

*Presidential address delivered at the annual meeting of the National Highway Traffic Association, New York City, on May 12, 1922.

First, inter-terminal transportation of freight by motor trucks. The advantages of the utilization of highway transport in this connection have been appreciated by railroad officials. It has been established in some cities, the most notable example being in the case of Cincinnati.

Second, intra-terminal and freight yard highway transport. It is believed that the utilization of motor trucks by railways in transferring commodities, especially l.c.l. freight, from cars to shipping platforms and warehouses would materially expedite the delivery of freight and would reduce idle time of cars standing on sidings.

Third, the collection and delivery of freight in municipalities and adjoining areas. This phase of highway transport, if used by railroads, would be a partial development of what is commonly known as the store door delivery plan. The ruling of the Interstate Commerce Commission in the case of the Baltimore development along this line may mean that it is impracticable for railroads at present to utilize highway transport in this manner except on such a large scale that the charge of discrimination in services rendered could not be brought against them. In England, we find a working illustration of railroads functioning as operators of highway transport in this field. One of the most notable examples is the case of the London and North-western Railway's comprehensive system of freight delivery by motor trucks in areas with headquarters at London, Birmingham, Manchester, Liverpool and Leeds. This railroad establishment this service in 1905 and in 1920 was operating over 350 motor vehicles.

Fourth, extension of transportation service through the medium of motor truck and motor bus routes. There are several methods of development practicable in this field. Urban and interurban electric railway lines may logically expand their passenger transportation facilities through the establishment of tributary motor bus routes. An illustration is afforded by the case of the Akron street railway's acquisition and operation of a fleet of motor buses to supplement their traction system.

Scotch Railway Has Motor Transport.

Steam railroads may enter this field through the development of intercity and rural motor express lines to carry both commodities and passengers. One of the most notable examples is afforded by the highway transport services of the Great North of Scotland Railway Co., which established its first highway transport service in 1903 and its first motor truck service in 1904. In 1921, this railway company was operating five passenger routes varying in length from $7\frac{1}{2}$ to $19\frac{1}{2}$ miles and seven intercity motor truck routes varying from $9\frac{1}{2}$ to $19\frac{1}{2}$ miles.

Railroads having stations in scenic areas may well give consideration to another branch of the Great North of Scotland Railway Co.'s highway transport service, namely the operation of a motor bus line for tourist traffic from Aberdeen through the lake region of northern Scotland.

The short line railroads, in many cases, are faced with the alternative of suspending steam railroad passenger or freight service or both due to the high cost of operation and maintenance and the low revenues received or of remodeling their transportation systems.

Several methods have been suggested in order that the returns on the investment may be materially increased.

Gasoline Motor Rail Car.

The gasoline motor rail car appears to have passed the experimental stage. The utilization of this vehicle on short line railways for the transportation of passengers, express packages and l.c.l. freight is a logical economic evolution of railroad transportation methods. The development of feeder service as way stations and extensions of motor rail car service at terminals by the utilization of motor truck and motor bus lines appears logical under favorable operating conditions.

Some short-line railroads may consider it advisable to replace the track with a pavement and operate their private right of way for the use of their own trucks and buses or as a toll road or a combination thereof.

In connection with some branches of highway transport, the railroad has certain economic advantages from the standpoint of overhead expenses. A traffic department is a part of its organization and may be readily expanded to supervise its highway transport activities. The basic principles of management in an efficient railroad traffic department do not have to be developed and the economic fundamentals of the relation between operating expenses and revenues do not have to be acquired at the expansion of either business failures or costly experience. The establishment of highway transport clearing houses and warehouses will usually mean not more than a rearrangement of its shipping and receiving platforms and buildings with an expansion of such facilities as the growth of its highway transport division demands. Garages and repair shops may be combined with locomotive and car sheds. Generally idle real estate is available for administrative offices, storage tanks and other structures as they are needed.

British Railways' Bill.

The future development of the utilization of highway transport by railroads should receive careful consideration from the standpoint of the efficient development of transportation by railway and highway. Railways may seek powers to operate highway transport both in connection with rail transportation and independent thereof. The present Railways Bill, now before the British Parliament, said to be supported by the Northwestern and Midland Railway group, contemplates an extensive development of the utilization of highway transport by railroads throughout the British Empire with the object of securing powers to conduct highway transport of commodities carried or to be carried by railroads or independent thereof. The public should bear in mind that some railroads may have ulterior motives in seeking to secure the right to operate highway transport. An unfortunate retardation of the development of efficient highway transport in a given community might be accomplished by a railroad by elimination of competition either through the control of routes by franchises or through cut throat haulage prices. If franchises are to be granted railroads for the development of highway transport services, such franchises must be safeguarded by regulations covering the service to be rendered.

The probable rapid development of the utilization of highway transport by steam and electric railroads and the fact that two-thirds of the state legislatures will be in session in the spring of 1923 leads to the conclusion that this Association should have an active National Committee, composed of steam and electric railway officials, highway transport operators, motor vehicle manufacturers, economists and engineers whose duty should be to formulate conclusions relative to the opportunities and rights of steam and electric railroads to function as operators of highway transport.

Committees representing Walkerville and Ford Councils last Friday reached an agreement on plans to amalgamate the two border towns. Solicitors of municipalities will be instructed to draft terms of the merger, which will be discussed at the next meeting of the committees before being submitted to a vote of the people.

Legislation to authorize the purchase and operation of the Toronto Suburban Railway Co. by the Hydro-Electric Power Commission on behalf of the City of Toronto, was introduced in the Legislature last Friday by Premier Drury.

Highland Creek viaduct, near West Hill, Ont., being built by the Ontario Government, will be 666 ft. 6 in. long and will cost about \$140,000. The height from the water level to the floor of the bridge will be 92 ft. 6 in. The structure is to be 42 ft. in width, with one six-ft. sidewalk. The floor will be of steel and concrete and will have solid abutments. The bridge will be supported by three steel towers on concrete pedestals.

CAUSES OF FAILURE IN CAST IRON PIPE*

Metropolitan Water Board's Pipe Tests — Analysis of Boston, St. John and Hartford Pipe — Relation Between Flexure and Breaking Load Should be Fixed

By F. A. McInnis

Division Engineer, Public Works Department, Water Division, Boston, Mass.

DURING the past twelve years, in Boston, nineteen failures of cast iron water pipe, 16 in. to 48 in. in diameter, have occurred; nine of them being due to settlement upon an unyielding support, three to accident, two to freezing, one to imperfect casting, two to demoralization of metal in "bad ground," while in two cases no reason for failure was apparent. As usual the fatal rigid bearing was the greatest offender; eternal vigilance, expressed in unrelenting inspection on the part of the Water Department, will alone minimize the danger from this cause in city streets. The pipe may be originally laid in a safe location, yet disaster may follow from the subsequent construction of sewers, conduits, subways, etc., under or adjoining it. All the failures of this kind mentioned above were due to settlement upon structures built after the pipe was laid, and all might have been avoided had reasonable care been taken to provide the necessary clearance around the pipe.

Quality of Pipe

It is not my intention to discuss the damage resulting from electrolysis, bad ground, improper filling, undue external loading, settlement, etc., nor to go at length into the imperative necessity that cast iron pipe be well made, properly laid and carefully protected from adverse conditions after being put in service. Much might be written on these points but I will briefly call attention to a probable cause of failure neither so much discussed or so appreciated; I refer to the quality of the pipe iron. This vital feature has not been sufficiently safeguarded in our specifications which require the test bars to support a centre load of 1900 lb. (N.E.W.V.) or 2,000 lb. (A.M.W.V.) and to show a deflection of 3 in. before breaking. The weak spot in these requirements lies in the fact that no direct connection is made between the loading and deflection with the result that in many cases the test bars do not show 3 in. deflection until the load is in excess of 1900 or 2000 lb., often times largely in excess. 2183 tests bars broken by the Metropolitan Water Board of Massachusetts during the past nine years give the following results:

3 bars showed .18 in. deflection at 1900 lb.
5 bars showed .19 in. deflection at 1900 lb.
33 bars or 15% of total number showed .20 to .21 in. deflection at 1900 lb.
389 bars or 18.0% of total number showed .22 in. to .24 in. deflection at 1900 lb.
229 bars or 10.5% of total number showed .25 in. to .28 in. deflection at 1900 lb.
437 bars or 20.0% of total number showed .28 in. to .30 in. deflection at 1900 lb.
905 bars or 41.5% of total showed less than .30 in. deflection at 1900 lb.
456 bars or 21.0% of total number showed .31 to .34 in. deflection at 1900 lb.
490 bars or 22.5% of total number showed .35 to .37 in. deflection at 1900 lb.
136 bars or 6.0% of total number showed .38 to .40 in. deflection at 1900 lb.
3 bars showed .42 in. deflection at 1900 lb.
2 bars showed .42 in. deflection at 1900 lb.

These results evidence metal of widely different quality. With a test bar deflection at 1900 lb. ranging from .18 to .43 in., we may safely conclude that the iron varied from "very hard" to "very soft"; omitting the extreme

cases the deflection at 1900 lb. ranged from .22 in. to .37 in., a condition far from satisfactory.

Test Bar Deflection

Water pipe iron, to secure the required resiliency and the necessary strength should show a test bar deflection of approximately .3 in. at 2000 lb. with an increased deflection of approximately .03 in. for each increase in load of 200 lb. above 2000 lb.

The question naturally arises, why not specify the composition of the iron, stating just what percentage of the different elements will be allowed, as is done in the manufacture of steel? There are practical objections to this course based on the differences in ores and coke throughout the country, on the necessarily different composition of thick and thin pipe, on the practical difficulty of making such a provision effective and on the possible undesirability of specifying both physical characteristics and composition of metal, etc. The writer, however, believes that the permissible sulphur content at least should be specified; with this provision, together with a logical relation between flexure and breaking load fixed in the test bar requirement, a long step forward towards uniform and satisfactory iron will have been taken.

Boston Water Dept. Practice

It has been the practice of the Boston Water Department to analyze the metal in a broken or cracked pipe, and the following determinations represent some of the results obtained over a period of approximately twenty years, many other analyses, entirely above suspicion, having been in the same period:

Pipe broken in middle of length when unloading from truck.

Year	Size	Sil.	Sul.	Man.	Phos.	C.C.	G.C.
1920	8 in.	1.32	.177	.85	.64	.82	2.7

Sleeve broken when water was turned on.

Year	Size	Sil.	Sul.	Man.	Phos.	C.C.	G.C.
1919	12 in.	1.66	.205	.28	.75	1.38	1.71

Pipe broken when water was turned on.

Year	Size	Sil.	Sul.	Man.	Phos.	C.C.	G.C.
1918	8 in.	1.74	.233	.45	.83	1.3	2.20

Pipe broken in transit from foundry.

Year	Size	Sil.	Sul.	Man.	Phos.	C.C.	G.C.
1915	10 in.	1.37	.171	.57	.75	.72	2.68

Pipe broken in transit from foundry.

Year	Size	Sil.	Sul.	Man.	Phos.	C.C.	G.C.
1915	12 in.	1.65	.185	.48	.75	.69	2.7

Pipe broken in transit from foundry.

Year	Size	Sil.	Sul.	Man.	Phos.	C.C.	G.C.
1915	10 in.	1.35	.133	.43	.79	.61	2.74

Pipe broken in transit from foundry.

Year	Size	Sil.	Sul.	Man.	Phos.	C.C.	G.C.
1915		1.33	1.21	.40	.80	.64	2.7

Pipe broken in transit from foundry.

Year	Size	Sil.	Sul.	Man.	Phos.	C.C.	G.C.
1915		1.47	1.21	.34	.80	.33	2.4

Six breaks occurred between October 19 and December 5, 1900, in a 48-in. supply main of the Boston system, laid in 1869, following an increase in working pressure of 15 lb. The analyses of the iron in these cases were as follows:

	Sil.	Sul.	Man.	Phos.	C.C.	G.C.
1	4.05	.07	.90	1.00	.04	2.38
2	4.25	.017	.90	.79	.08	3.56
3	4.10	.037	.83	.86	.08	2.85
4	4.18	.027	.93	.90	.08	3.06
5	4.27	.051	.86	.928	.06	2.62

S. John, N.B., Experience

In St. John, N.B., 1916-17, one of the two 34-in. mains supplying the city failed several times, as it had been in the habit of doing at intervals in the past. The pipe was

*Paper read at the 42nd Annual Convention of the American Water Works Association, Philadelphia, May 15-19, 1922.

cast in England many years ago. The following are analyses of the metal in the broken pipe in three cases:

	Sil.	Sul.	Man.	Phos.	C.C.	G.C.
1	2.94	.035	1.08	.99	.56	2.59
2	2.36	.068	1.22	1.00	.51	2.79
3	2.80	.03	1.05	.90	.58	2.80

The following analyses of a 24-in. main broken in the Hartford, Conn., system in 1921, has come to my attention:

	Sil.	Sul.	Man.	Phos.	C.C.	G.C.
1	2.22	.094	.36	1.39	.07	2.92
2	2.61	.10	.23	1.86	.03	2.77

Some of these determinations can safely be termed "horrible examples"; witness the Boston 48 in. with C.C. .04 Sil. 4.05 and the Hartford 24 in. with C.C. .03 Phos. 1.86; one of them, the St. John 24 in., is in the freak class; the remainder, particularly those in which the sulphur content is abnormally high, warrant the conclusion that the quality of the iron was a contributing if not the direct factor in the failure of the pipe. The broken pipes were cast in main pipe foundries throughout the United States with two exceptions, namely, the St. John 24 in. which was made in England, and the sleeve broken in 1915, which was cast in a small jobbing foundry in Boston. As a rule two specimen pieces, taken from different parts of the broken pipe, were submitted for analysis and in no case was a substantially different result obtained from the bell and spigot end of the pipe.

Cast iron pipe is not a homogeneous material. When pig iron and scrap iron are melted and made into water pipe, the resulting cast iron must vary to some extent in its physical characteristics, owing to differences in the material used in the cupola and to the methods employed in moulding, cooling, etc. The process of manufacture demands a high degree of skill and oversight if the product is to maintain the uniform quality desired. That this condition does not always exist is apparent to those familiar with the output of cast iron water pipe. There are notable exceptions where this criticism does not apply, but on the whole it would appear that the general standard of manufacture might be raised to the advantage alike of maker and consumer, to the end that a well coated pipe of uniform and sufficient strength, equal at least to the best of the present product, may be absolutely depended upon.

The writer is one of those who believe in cast iron pipe for water works distribution and supply systems, recognizing it to be best suited to meet the conditions usually found, and as its friend, advocates the application of more scientific methods in its manufacture than now obtains in many cases.

The U. S. Bureau of Standards, in co-operation with interested manufacturers, is to carry out an investigation of stucco bases made of woven wire cloth and expanded metal lath. It is expected that 3 types of base now in general use will be applied over sheathed construction, and the performance of the various panels will be noted and analyzed.

A complete survey of iron ore resources of British Columbia is to be commenced this summer. The Canadian geological survey branch has agreed to undertake this important work in co-operation with the provincial department of mines. The object is to obtain conclusive information as to the possibility of this province supporting a large capacity iron and steel plant.

The Niagara Peninsula Branch of the Engineering Institute of Canada held their last monthly meeting for the season in the Engineers' Club, Thorold, on May 17 with a large attendance. The speaker of the evening was Lieut.-Colonel H. C. Boyden of the Portland Cement Association, Chicago. Col. Boyden spoke of the most modern developments in the manufacture and use of concrete.

SOME METHODS OF FIRE PREVENTION*

By T. S. Glover

PRIMITIVE people have made of fire a god. To us it is in danger of becoming a devil. One of the outward signs that distinguished man from the beasts of the field is the use of fire, and without it our civilization would have been impossible. The uses of fire are obvious, but the abuses of it are so little realized by the vast majority of people, that today we have special departments whose business is solely to shake us from our blissful slumbers, and hammer cold facts into our heads about the tremendous loss of life and property that is now, hourly, going on round about us. The expression "hammer" is used advisedly, as any milder form of persuasion is useless, and can never succeed in breaking through our attitude of indifference to this glaring evil.

A Personal Problem.

Those of us who have considered the human make-up (and which of us has not) are eager to admit the beauty of self-control, of the strong and healthy mind that leads. We admire the great efforts that the engineer has made in controlling and directing Nature by dams, canals and all the many works he has designed. And yet, in the face of this lawless devil, that tears madly through our land, respecting neither low nor high, waving his red torch of destruction, we placidly go about our business, hoping that we at least may be spared. Then perhaps we see a fire, or read about some new triumph of the demon of fire, and wonder why someone does not do something to prevent this waste. When we have reached this point there is some hope of improvement. In the particular circumstances in which each one of us is placed there is opportunity to awaken people to a sense of the futility of this fire waste, and it is only when the great mass of public opinion decides that this shall not be that it will cease. There are men with brains to design fireproof structures if we want them. Till we want them enough to be willing to pay the comparatively small extra cost the same orgy will continue.

We therefore want to prevent loss by fire. The word "prevent" means "coming before," or, as we should say, "getting ahead of." Our fire demon is endowed with intelligence of a high order, but nevertheless we have sufficient accumulated knowledge to be able to forestall his machinations, if we really set out to do it. Our frame house, lit by kerosene lamps, is an easy mark for him, and with what fiendish delight does he pounce on the little child playing by the unguarded fireplace. The airy tossing of our cigarette end into space, or what is more likely, into the waste-paper basket, is as good an opening for him as that offered by the man who looks for a gas leak with a candle. It is not so much technical knowledge we need, as ordinary common sense and a stiffening of our mental and moral fibre. We are so used to the comforts and conveniences of our modern life that we see no reason why we need go to a little trouble in the small things of our daily round.

Value of Education

In a recent address before the Ontario Fire Prevention League, Dr. H. J. Cody stated that in his opinion the best way to bring about a great national advance or induce a beneficial national change, was to deal with the children. Train the child, and then, as the twig is turned, so will the tree be. It is far better to deal with the children than with the adult.

This means education, not by the teaching of a long list of "don'ts" so much as by the inculcation of strong positive principles, such as cleanliness, law, order, duty and restraint, obedience, discipline. The child with a clear and well-ordered mind will instinctively refrain from un-

*From Transactions, University of Toronto Engineering Society, being an essay in the recent competition conducted in the Faculty of Applied Science, for prizes offered by the Fire Marshall of Ontario.

tidy and slack practices, such as letting off squibs in the woodshed. He will know enough to go out into a field for the fireworks season. To quote Dr. Cody again, "The two great enemies of property and of fire prevention work are probably carelessness and uncleanness; both of these have their roots in certain features of human nature. They are not merely material accidents, but are related to personality, and so, being related to personality, can be dealt with by the processes of reason and education along proper lines."

Facts are very potent, solid arguments, and if there are any who need convincing of the magnitude of the danger, let them ponder the following. In the United States and Canada, estimates show a casualty list of twelve thousand persons killed each year by fire. As in war, the deaths are not nearly equal to the injured, so that thirty thousand casualties a year from fire is no exaggerated three hundred million dollars. Much of this loss is foodstuffs, and necessities of life, a waste which is positively criminal. And who is responsible? In some cases the builders and architects, but in far more cases some foolish and careless person who handles fire in the form of matches, burning tobacco, and a hundred other forms. Those who have investigated the facts closely tell us that in Europe conditions are not nearly so bad. The reason is that the people have been educated, and know the dangers of fire, and the precautionary measures to be adopted against it. They realize that their country's prosperity depends on the efficiency of its people and industrial plants, and that the matter is not merely one which concerns insurance companies and fire brigades, but that it is the concern of each member of the community.

In this country the recent efforts of the Fire Prevention League have resulted in a very marked decrease in fire losses. In Ontario, during the first six months of 1919, a reduction of 40 per cent. was effected—proof that the educational methods used were sound.

Defective Construction

Assuming now that the sympathy and co-operation of the large body of loyal citizens has been enlisted, let us turn to examine the responsibility of the structural engineer in the matter of fire prevention. Competent authorities state that the largest single factor contributing to the excessive fire waste in Canada is the indiscriminate use of wood for structural purposes. Out of possibly two million buildings, less than one-tenth of one per cent. has been built with proper consideration of fire safety. Nearly 70% of our buildings are of frame construction, and the majority of our brick buildings are inadequately protected against fire. It must, therefore, necessarily be a long time before the effect of more stringent building regulations will be felt and the problem consequently becomes not merely one of building new fireproof structures, but of remodelling existing ones so as to give a much greater factor of safety against fire.

Comparison of fire losses and of structural conditions in Canada and Europe leads to the conclusion that a radical change in building methods is fundamental to the curtailment of Canada's fire losses. Serious fires in Europe are exceptional occurrences, and conflagrations are almost unknown now. The fire departments in the principal European cities are certainly no better than ours, and in the smaller places, comparison would be ludicrous. Their greater immunity from destructive fires is undoubtedly due in large measure to superior construction.

A lack of thoroughness marks a large amount of our Canadian building, due to our giving way to the modern cry for speed. This leads to insufficient supervision and carelessness, not in the matter of structural safety, but of safety against fire. The responsibility for these conditions may be equally divided between the owners, architects, contractors and public authorities. Speculation and the desire for large returns by investors have been the cause of much poor construction in Canada. Efficient construction requires time.

Objection has been frequently made to the passage of ordinances requiring brick construction, on the ground that

it would prove a hardship to builders by compelling a larger initial expenditure. After careful examination of the merits of this argument, it has been found that the additional cost in Canada of solid construction is so small that the prohibition of frame buildings, at least in cities and towns, would involve no real hardship.

The relation of construction to the safety of the lives of those who occupy buildings is self-evident. The danger to human life is influenced by (1) the material used in construction, (2) the design, (3) the facilities for escape, and (4) the physical and mental condition of the occupants. It is clear that the materials should be incombustible, and be employed in such manner as to overcome any inherent defects or weaknesses. Unfortunately, a building, even when constructed of fire-resistant material, and equipped with every safety feature and device, may be filled with inflammable and combustible contents, capable of generating gases, smoke and heat sufficient to destroy the lives of the occupants. Well designed and constructed fire resistant walls will, however, confine a fire to the space in which it originates.

The safety of a building is largely influenced by its design. The maximum separation of the exits, the safe enclosure of the stairways, the proper introduction of fire walls and the character and degree of the fire protection are all important details. In order to secure economy of design it is necessary that the purposes and uses of the building should be definitely known. Thus, the correct amount of fire protection may be provided against the exterior fire hazard, and, by dividing walls or partitions, fire doors and fire-extinguishing apparatus and equipment, protection may be provided internally.

Value of Fire Walls

The usual means of exit are (1) elevators, (2) outside fire escapes, (3) stairways, and (4) the fire-wall. There are only two kinds of safe exits—the enclosed fireproof stairway and the fire-wall—but the former has serious limitations and is not suitable for crowded buildings. The only real and practical solution of the problem of safety in buildings is a bi-sectional fire-wall. It is, moreover, the least expensive solution of the problem if properly and economically applied. There is, unfortunately, a widespread prejudice against the fire-wall, but this is largely due to the lack of knowledge of the manner of its application to the life hazard.

Its merits and advantages as a safeguard and protection to property have long been recognized by underwriters. Where it is introduced, the conditions in buildings are so changed that large economies can be made in the cost of additional exit facilities. In most cases this saving more than offsets the entire cost of the fire-wall and materially reduces the total cost of the building. There should be at least one stairway and one elevator on each side of the fire-wall and the wall should have at least two openings in it at as great a distance from each other as practicable, and both should be closed by standard fire-doors.

It is improbable that a fire will occur on both sides of the fire-wall simultaneously. Should it occur on one side, the people on that side would pass through the doorways in the firewall, close the doors after them and be perfectly safe. The half of the building in which the fire occurs can usually be emptied in less than a minute if there are not more than 300 people on each floor, and an average of 150 have to pass through the doorways. If the principle of the horizontal escape presented by the fire-wall is correctly applied in new buildings, a most satisfactory method of securing safety at comparatively small expense will be obtained.

The minute details of this work afford material for a long course of study in themselves, and the engineer has first of all, in designing any structure, to consider its strength to bear the load expected of it. But this does not imply an absolute disregard of the principles of fire protection. On the contrary, a closer study of such principles is becoming a necessity in our engineering colleges, if we are to proceed in the campaign for education in fire prevention equally at all points of the line.

ONTARIO PROVINCIAL HIGHWAYS*

By George Hogarth,

Chief Engineer of Highways, Department of Public Works,
Ontario.

ONTARIO has a system of provincial highways 1,812 miles in length which joins every city in the southern portion of the province. These roads threading through the counties of older Ontario, serve as main routes of travel between distant points and at the same time are of benefit to local district market centres. Roads in Ontario are supervised by various authorities, and in order to give a clear view of the position of the provincial highways in the road development program, a short description of the different kinds of roads is necessary.

In the original surveys of townships, road allowances were left as concession lines, or side lines, around blocks of land, and the township council has authority over such roads which it builds and maintains. The province to aid the townships with the work grants a bonus of 20% of the cost of the work.

Throughout the counties there are many roads which serve as main market roads to towns, cities, and shipping points. Such roads are of more importance to the community than the township road, require better construction, greater width and stronger surface, and the counties have, therefore, been authorized to assume and construct a system of county roads. Usually, about 15% of the road mileage in the county is taken as county roads and towards the cost the Government contributes 40% of the cost of construction and maintenance.

Classification of Provincial Highways.

Should some of the roads taken as county roads be important thoroughfares leading to towns and cities, or main routes through a county, they may be designated provincial county roads, in which case the government contributes 60% of the cost of construction and maintenance.

In the immediate vicinity of cities, all main roads require special attention to resist the heavy traffic, and in the case of county roads for a distance from the city, a commission may be appointed by the county and the city to have charge of and build such main highways. The highways assumed are known as county suburban roads and are paid for, 30% by the city and county, and 40% by the Government. Very important suburban roads may be designated provincial county suburban roads, in which case the city and county each pay 20% and the government 60% of the cost of the work.

On provincial highways, 80% of the cost of the work, together with all overhead charges and land required, is paid by the government, and 20% by the county in which the road is situated. In the vicinity of cities, a certain mileage of provincial highways may be designated provincial suburban, in which case the city and county each pay 20% of the cost, and the government 60%. Provincial highways are not designated entirely through towns but only extend into the municipality where the road is in front of farm lands. Where the continuation of a provincial highway passes through the business section of a town, the government pays 40% of the cost of the central 20 ft. of pavement laid by the town on the business street.

It will be readily seen that with the above system in operation, those roads requiring attention because of heavy and important traffic are so provided for, that every facility for proper construction and maintenance is given.

The provincial county suburban roads, provincial suburban and provincial highways are all built to a high standard, with paved widths of 18 or 20 ft., with a full top width of road of 30 ft., and with adequate and effective drainage to protect the investment in surface. In addition, the provincial highway cross section provides a space for

sidewalks on each side of the road, proper space for public services, such as rural free delivery post boxes, telephone, telegraph and power poles, as well as a location for underground services, water and gas.

The roadway portion of provincial highways is surfaced with material suitable for the traffic passing over it. Should the traffic be medium, a gravel road well drained and maintained, gives an economical surface, while for heavier traffic oiled macadam or penetrator surfaces or pavements, such as asphaltic concrete or cement concrete, are provided. Because of the fact that the heaviest of traffic is found just outside cities, it has been found necessary in many cases to construct pavements as fast as ruling conditions permit, while on sections remote from cities, ditching operations, gravelling of long stretches and the bringing of the entire system up to a uniform standard are carefully attended to. In the year 1921, the Department of Public Highways graded 70 miles of road, gravelled 120 miles, placed macadam base on 33 miles, constructed finished macadam on 40 miles, bituminous macadam on 17 miles, asphaltic concrete on 20 1/2 miles, and cement concrete on 25 miles, besides building 1,200 culverts and bridges.

To build a gravel road properly requires a dry roadway surface which in practically any location can be obtained by digging a ditch on each side of the travelled way. After the earth has been properly levelled and trimmed, a light coating of gravel about 4 in. in depth and 8 to 10 ft. wide can be rapidly spread. This first layer should be carefully levelled and all stones raked ahead so as to be buried under succeeding loads of gravel. While gravelling progresses, the surface of portions completed should be kept smooth by means of the log drag, so that as the material is compacted it will be smooth for traffic. After the first layer of gravel has been consolidated in place, subsequent layers may be added as required, but in all cases care should be taken to see that the gravel is spread thinly to a depth of not more than 2 in. Such a depth, properly spread and dragged and applied, if needed, spring and fall, will give excellent results. Gravel roads are readily built because over a large portion of Southern Ontario good road building gravel can be obtained on or close to the road and the cheapest of road building methods, intelligently applied, will give untold satisfaction.

Macadam.

Macadam roads, being built of crushed stone, are usually desirable where traffic is heavy and where field stone or quarry stone can be easily obtained. In sections of the county where bed rock does not exist, field stone may be gathered into piles convenient for crushing, and portable crushers used to crack the stone to proper size.

In localities well served by railways and having commercial crushed stone available at reasonable rates, such material can be used to construct a two-course macadam, having large stone of about 4-in. size in the base course, and 2-in. stone in the top course. The lower course is usually 5 or 6 in. thick after compression and top course 4 in. thick after compression. Surfaces of macadam roads are built with a crown of 1/4 to 3/8-in. per foot so as to give sufficient drainage.

Bituminous macadam surface consists of a depth of 2-in. stone about 3 1/2-in. in thickness, into which hot tar or asphalt is forced under pressure. The stone is carefully levelled and may be given a light rolling before penetrating. If tar is used it is heated to about 250 deg. F. and if asphalt, to about 350 deg. F. In the first application, about 1 1/2 gal. of bitumen per sq. yd. is used, and while the material is still hot and soft, stone chips are spread rapidly over the road surface. The roller is then passed over, a second light coat of bitumen applied at a rate of about 1/2 gal. per sq. yd., then a light coat of stone chips applied and, after a thorough rolling, the roadway may be opened to traffic.

Asphaltic concrete surface is laid in two courses each 1 1/2 in. thick, on either a good macadam or concrete foundation. The lower course of the mix uses sand and coarse stone up to about 1/2-in. in size, while the top course may

*Address delivered before the Civil Club, University of Toronto.

contain only a well graded sand. The upper or lower course is mixed separately in an asphaltic mixing plant and about 11% of asphalt is sufficient to give good results. Such pavements will carry the heaviest of traffic and give service over a period of years.

Concrete pavements may be constructed of cement, sand and good gravel or crushed stone in the proportions of 1 part of cement to $1\frac{1}{2}$ parts sand to 3 parts gravel or stone. The thickness at the sides is usually 6 in. and $8\frac{1}{2}$ in. in the centre.

Transverse expansion joints may be left every 50 ft. and in some cases a longitudinal centre joint may be desirable. Good results under heavy service conditions may be confidently expected from any well laid concrete pavement.

Structures.

Structures on provincial highways are built to carry Class C loading, the concentrated load of which is a 20-ton road roller. Spans of from 2 to 20 ft. are built of concrete with flat slab reinforced top. Longer spans are steel girders or trusses. The clear width of roadway is 24 ft., or greater, if special conditions demand, and if the bridge is in or near a large centre, one or more sidewalks 6 ft. in clear width are provided. All culverts are built of such a length that the full 30 ft. of top width of road can be placed between the end walls.

Where excessive grading is not required, the maximum grade on the provincial highways is 5%, but in exceptional cases this may be increased to 7%, which is as steep as any highway grade can safely be.

Every effort is being put forward to make the highways attractive by tree planting and attention to the roadside so that people will be drawn to the main roads and tourist traffic be encouraged as it is one source of revenue needing development.

The highways entering the cities are being attended to immediately and surfaces completed so as to serve those portions of the system which have the heaviest traffic. To finish such pavements requires, in many cases, bridges, and new locations for main roads to give direct access to large arteries of travel in the cities.

The highways now completed are giving efficient service to sections of the country which urgently required rapid transportation, and as fast as public opinion and finances permit, the benefits of such construction are being given to an ever widening area of the Province of Ontario.

POWER LOSS IN AUTO TIRES.

UNITED States Bureau of Standards has a rubber laboratory equipped with a special dynamometer for determining, among other things, the power loss in automobile tires. A great many of the standard makes of tires have been tested on this dynamometer, and valuable data are being obtained concerning the percentage of the power of an automobile engine which is absorbed by the tires under various conditions.

Some interesting figures have already been secured as a result of this work. For instance, an average 4 in. fabric tire, under conditions of normal load and air pressure, will absorb approximately .90 h.p. due to rolling resistance at a speed of 25 miles per hour. Under the same conditions, the power loss in a 4 in. cord tire is approximately .60 h.p., while a 5 in. cord tire represents a loss of 1.20 h.p. The extent to which different parts of the tire contribute to the power loss has also been investigated. It is estimated that from 80 to 85% of this loss is in the carcass, the tread contributes 10 to 15%, and the tube probably less than 5%.

Under the auspices of the Windsor branch of the Engineering Institute of Canada, Colonel H. C. Boyden, of the Portland Cement Association, Chicago, addressed a fair sized audience on May 19 in the Windsor Collegiate auditorium, on "Recent Developments of Concrete."

CANADIAN ENGINEERING STANDARDS ASSOCIATION

SEVENTH meeting of the Main Committee of the Association was held in Ottawa at the offices of the Association on April 24th. H. H. Vaughan in the chair. This meeting being the first held since the death of Sir John Kennedy, the resolution of condolence which was passed by the Committee in November last was reported as having been forwarded to Lady Kennedy, and the chairman and other members of the Committee spoke feelingly of the loss sustained by the Association through Sir John's death.

The following changes in the personnel renominations of members of the main committee were reported:

Sir Alexander Bertram, nominated by the Engineering Institute of Canada, replacing W. F. Tye.

C. W. Lefebvre, nominated by the Ecole Polytechnique, replacing Arthur Surveyer.

Dr. L. A. Herdt, renominated by McGill University.

Dr. R. A. Ross, renominated by the Research Council. Prof. P. Gillespie, renominated by the University of Toronto.

T. F. Sutherland, renominated by the Canadian Institute of Mining and Metallurgy.

A. R. Goldie, renominated by the Canadian Manufacturers' Association.

W. A. Bowden having been nominated as a member of the main committee by the Department of Railways and Canals, replacing Col. C. H. Monsarrat, it was decided to co-opt Col. Monsarrat as a member so as to retain his services on the Committee.

A number of gentlemen serving on various Committees of the Association were elected to membership of the Association.

Work of the Association.

The report by the Secretary, R. J. Durley, on the work and progress of the Association up to March 31 was laid before the Committee and approved for distribution to members of the Association.

Discussion followed on various points of interest among which the following may be mentioned:

As regards the work of the sub-committee on the Canadian Electrical Code it was decided to forward to the Minister of Trade and Commerce a memorandum outlining the present situation in regard to this question, and requesting him to convene a meeting of representatives of the various provincial governments, to discuss the possibility of interprovincial agreement and to acquaint the provincial governments with the difficulties now experienced by the Industry. The following resolution was unanimously passed:

"RESOLVED that the Memorandum on the proposed Canadian Electrical Code be approved, and that the Secretary be directed to forward it to the Minister of Trade and Commerce, calling his attention to the unsatisfactory situation at present existing in Canada due to the lack of uniformity in the requirements for electrical appliances and construction in the various provinces, and requesting the minister to consider the advisability of calling a conference of representatives of all the provincial governments with this Association to discuss the matter with the view of obtaining interprovincial agreement and action."

On the suggestion of Geo. A. Mountain it was decided to form a committee to consider the desirability of formulating standards for crossings of water and other pipe lines under railway lines.

As a result of a communication from the sub-committee on "Concrete and Reinforced Concrete" the committee discussed the best means of dealing with the "Standardization of Sieves and Screens" in Canada. It was pointed out that standards of this kind have been adopted both in England and in the United States, and that the question is of great interest not only to persons interested in cement and concrete but also to the mining and metallurgical industries, to those dealing with road materials, broken stone, etc., to industrial chemists, and others. It was decided that the formation of a committee to deal with this

question should be proceeded with, and the matter was referred to the executive committee for action.

The secretary reported that in response to an invitation received from the American Engineering Standards Committee, John Murphy, electrical engineer, Board of Railway Commissioners, had acted as the representative of the C. E. S. A. in attending a conference held in New York to discuss the measures to be taken in the United States with a view of obtaining uniformity in specifications for overhead crossings of electric lines over railways. This question in Canada is largely under the jurisdiction of the Board of Railway Commissioners, and in order to obtain as far as possible an agreement between the requirements in force in Canada and those proposed in the United States, it has been arranged that the American proposals, before their adoption, shall be forwarded for consideration and comment to a C.E.S.A. committee which is to be organized for that purpose.

An invitation from the A.E.S.C. to take part in a conference regarding colours for traffic signals was received. It was decided to thank the A.E.S.C. for this invitation, and to enquire whether a method of dealing with the matter similar to that adopted in the case of overhead crossings would be satisfactory to the A.E.S.C.

A suggestion from H. C. Bertram of the John Bertram & Sons Co., Ltd., Dundas, Ont., was laid before the committee, outlining a scheme for the development of dimensional standards in Canada in connection with machine tool building. The committee expressed the opinion that action along the lines of Mr. Bertram's suggestion was very desirable, and the matter was referred to the chairman of the sectional committee on machine parts with a request for action if possible.

A letter from the Dutch Standards Committee was considered inquiring whether there is any objection on the part of the C.E.S.A. to the Dutch Standards Committee collecting and publishing the information regarding progress of work received periodically from the various national standardizing bodies, the collective scheme being then published periodically in the technical press. The secretary was directed to reply that so far as can at present be seen there is no objection to the Dutch Committee using the reports periodically furnished it by the C.E.S.A. in this way.

Election of Officers.

On the motion of Dr. J. B. Porter, seconded by Mr. Mountain, it was unanimously resolved that H. H. Vaughan be appointed Chairman of the C.E.S.A. in succession to the late Sir John Kennedy.

Mr. Vaughan expressed his willingness to accept the honour thus conferred, and pointed out that, in his view, the thing which was now most necessary for the success and growth of the C.E.S.A. was the encouragement of an effective interest in the work of the Association on the part of the manufacturing and industrial industries, this support being just as important and advantageous as the assistance rendered by engineers or scientific and technical societies.

The election of Mr. Vaughan as chairman requiring the appointment of a second vice-chairman, T. A. Russell and D. H. McDougall were unanimously elected as vice-chairmen, together with Dr. Porter as honorary secretary-treasurer, these gentlemen, with the chairman, forming the executive committee.

The meeting of the main committee was followed by the fourth Ordinary General Meeting of the Association, at which the annual report on the progress of work was presented, together with the auditor's financial statement for the year.

The annual convention of the National Lime Association will be held June 14-16, Hotel Statler, Cleveland, Ohio. The activities of this convention will deal with the technology of the uses of lime and the industrial problems of manufacturing and marketing lime.

Letter to the Editor

BEACH WATER WORKS PUMPING PLANT AT HAMILTON

Sir—The article on the above plant by Mr. R. de Bruno-Austin, in "The Canadian Engineer" for May 9, was most instructive. At a time, like the present, when almost all mechanical engineering appears to be at a stand-still, there is little else to do than study work done in the past so as to be in a better position to tackle jobs which we hope the future holds in store.

I take the following from the test figures on the steam-driven pumps: Steam pressure, 169.7 lb.; vacuum, 28.32 in.; barometer, 30.06; water, h.p., 725; pump efficiency, 80%; gearing efficiency, 98½%; steam consumption of turbine (actual) in lb. per hr., 11,901; steam consumption of air pump, 172; steam consumption of boiler feed pump, 403; total steam used per hr., 12,476; duty in million ft.-lb. per 1000 lb of steam, corrected for moisture, 117.16; allowance for moisture, 1.74%; actual moisture present, 2.37%. Deducting from the above figures and taking the moisture present into account the actual head of heat (or heat drop) available during the test was 330.5 B.T.U., so that the overall efficiency of the main unit, excluding the auxiliaries, was equal to $2547 \times 725 / 11,901 \times 330.5 = 47\%$, relatively to the Rankine cycle.

If the steam had been dry the available head of heat would have been 337 B.T.U., and, reducing the steam consumption from 11,901 lb. per hr. to 11,694 in accordance with the allowance for moisture, the efficiency by the formula above works out practically the same as in that case. The allowance for moisture, therefore, seems to have been a fair one.

Taking the heat of vaporization of the steam at the pressure given as being equal to 847 B.T.U., and neglecting the steam used by the air pump the loss of heat per hr. by the steam on its way to the engine room must have been equal to $.0237 \times 11,901 \times 847 = 239,000$ B.T.U., an excessive amount for 200 ft. of 6-in. piping, unless it was uncovered at the time.

This loss of heat excited the curiosity of the writer to see what effect, in this case, the addition of 100 deg. super-heat might have had. To obtain about the same duty as the guarantee the vacuum might be taken at 27½ in. In other words, let the heat drop take place higher up in the temperature-entropy diagram. For steam at a pressure of 170 lb. gauge and superheated 100 deg. the temperature would be 475.3 deg. Fah., and—neglecting the slightly greater radiation loss at the higher temperature—taking the same heat loss as before the temperature of the steam on arrival at the turbine stop valve would be $475.3 - (239,000 / 11,700 \times .58) = 440$ deg. This assumes 11,700 lb. of steam per hr. to be required by the turbine and air pump together under the new conditions and the mean specific heat to be .58. There is, then, more than enough superheat to see the steam through 200 ft. of piping without condensation. The available head of heat between the limits of 170 lb. at 440 deg. and 27½ in. vacuum is 334 B.T.U., a little less than that under the conditions of the guarantee.

Now, under the test conditions, the over-all efficiency of the main unit was equal to .47, which, divided by the product of the pump and gearing efficiencies, gives the turbine efficiency as .596 on the Rankine cycle, which is very good for a comparatively small turbine, especially with wet steam. It is fair to assume, then, that this turbine would have an efficiency of .605 when supplied with steam carrying a superheat of 65 deg. at the stop valve. Multiplying by the product of the pump and gearing efficiencies brings the over-all efficiency of the unit to .477. The steam per hr. required by the turbine only would then be equal to $2547 \times 725 / .477 \times 334 = 11,600$ lbs.

705 Colbrook Ave., Montreal, May 19.

BUILT TO ENDURE—Now booklet, published and distributed free on request, by the Koehring Co., Milwaukee, Wis., and Toronto, Ont.; 32 pages and cover. As a commercial booklet this publication is somewhat unique in lavish decoration and in the quality of materials and printing. The cover, embossed in blue and gold, bears out the title of the booklet, "Built to Endure," being of the highest quality of art stock and nearly as heavy and tough as leather. Heavy suede-finish coated paper is used, and the booklet is printed throughout in four colors, every page bearing some elaborate decoration. The text of the booklet is by Philip Koehring, president of the Koehring Co., and the etchings in color are by W. M. Young. The booklet is designed and produced by the Commercial Art Engraving Co., Chicago, under the direction of the advertising department of the Koehring Co., who describe the purpose of the booklet as follows: "In this booklet we have tried to pay our tribute to concrete—solely by describing and picturing a few of the wonders wrought in concrete. The romance of concrete is truly an epic—an epic in plastic stone, stretching thousands of years into the past, and who knows how many thousands of years into the future? From the Romans to the Americans; from slave-driven manual labor to the modern concrete-mixer; through all these years concrete has endured. Therefore, concrete has made a big place for itself in modern construction work; therefore, concrete finds new work to do daily; and, therefore, Koehring builds concrete mixers. Desiring to portray the romance of concrete, the beauty of concrete, and above all the permanency of concrete, we gathered together in one booklet, illustrations and facts concerning ancient and modern concrete structures built to endure." Throughout the booklet the ancient and modern present a striking parallel; an illustration and description of the Colosseum at Rome appears on one left-hand page, for instance, and on the right-hand page facing it is an illustration and description of the stadium used by the New York Yankees' Base-Ball Club; the Seine Bridge is contrasted with the Hell's Gate Bridge, the Pyramid of Cheops with the Black Hawk Monument, the Applan Way with the Lincoln Highway, the Roman Viaduct at Nîmes with the Tunkhannock Viaduct, and the Acropolis at Athens with the Bush Terminals.

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UNDERWATER CUTTING OF METALS.

VALUABLE aid to the construction engineer and to those engaged in the work of salvage of sunken ships is afforded in the perfection within recent years of the underwater torch for the cutting of metals. Problems of this kind usually involve much difficulty and must be solved with the greatest haste, since in them the emergency factor predominates. It frequently happens that metal parts, or structures, such as pipes, cables and the like must be removed in order to permit reconstruction, and, in the salvaging of ships holes must often be cut through the sides to enable divers to enter. In cases where steel bridge wreckage must, in the interests of navigation, be removed, a cheap and rapid method of cutting away the distorted metal is most desirable.

The improved underwater cutting torch is not only simple in construction, but easy to operate. Something over ten years ago the Germans made use of such a device in the form of an oxy-acetylene flame contained in a cup-shaped nozzle. This device, however, could scarcely cope with thick metallic masses, or in very cold water, or at very great depth. Improvements were made upon it by the French, but in the past few years American inventors have been able to develop the apparatus still further. As now employed, it consists merely of a single carbon electrode pierced longitudinally by two parallel tubes through which a cutting gas is fed to the zone of the arc. When the current is turned on and the tip of the electrode placed a fraction of an inch from the metal to be cut, the torch comes into operation.

A striking use for this equipment in emergency work was recently described in the Scientific American. This

consisted in replacing a damaged section of 36-in. cast iron water pipe across the Narrows between Staten Island and the Borough of Brooklyn. A heavy spud of a dredge had been allowed to fall on the pipe and rupture it. This pipe was located 50 ft. below the surface and under 23 ft. of mud. After dredging operations had removed the overlying soil the torch was used to cut off the upper half of the bell of the damaged section and the entire bell of the adjacent section along a sloping cross section. This done, it was a simple matter to hoist the damaged pipe to the surface and replace it by another. The torch used was able to cut through the 1½-in. cast iron wall at the rate of four to six inches an hour, the cutting of the bell being of course much slower.

With this improved equipment for emergency repairs and salvage, it should be possible for engineers to undertake work which has hitherto been impracticable. It will undoubtedly mean the reduction of serious inconvenience to large populations when subaqueous water mains are put out of commission and the supply must be cut off until repairs are completed.

EXTENSION OF AUTOMATIC TRAIN CONTROL.

IN a recent order the Interstate Commerce Commission of the United States required 49 railroads to show cause why they should not install automatic train control equipment before July 1, 1924, on the sections of their lines where the traffic is most dense. This step was taken only after exhaustive study of the whole question of signal and control systems extending over 14 years. The engineers of the Commission have become convinced that automatic control is both practicable and necessary. It is not difficult to appreciate the force of the argument when the high percentage of the railway fatalities on this continent is considered.

While in the present condition of the railways in Canada no such order as this is likely to be made in the near future, from it the trend of progress is evident. It is not unlikely that when the railways have been placed on a sound operating basis that similar steps will be taken by those who direct the railways in this country.

PERSONALS

FRANK P. VAUGHAN, manager of the Vaughan Electric Co. Ltd., St. John, N.B., received the Honorary Degree of M.Sc., in electrical engineering from the University of New Brunswick, Fredericton, N.B., at Encaenia, May 18.

ROY PATTERSON, of Galt, Ont., who has been assistant to city engineer D. T. Black for the past 18 months, has left Galt and will reside in Thorold, having accepted a position with the Webster Construction Co., of London, Ont.

IRA W. MCCONNELL, vice-president of Dwight P. Robinson & Co., New York and Montreal, has returned home after a visit to Brazil, where he has been located since last September, in charge of the irrigation work which his company is doing for the Brazilian Government.

C. W. DILL, superintendent of highways for the Saskatchewan government, has severed his connection with the department after occupying the post for over three years. Mr. Dill is well known in engineering circles in the province. Only recently he was elected vice-president of the Saskatchewan branch Engineering Institute of Canada and about the same time was elected president of the Saskatchewan Civil Service Association.

H. G. DIMSDALE, engineer of the Lacombe Northwestern Railway, has been appointed highways commissioner for Alberta, under the new public highways act passed by the last legislature. He will take office, it is understood, at once and will carry on necessary investigation work during the summer and fall on the classification of roads, and establishment of highways, and other information preparatory for the act coming fully into force at the beginning

of 1923. Commissioner Dimsdale has already had a wide engineering experience in Alberta. He was chief of surveys on the Edmonton-Dunvegan and Alberta Great Waterways Railways in 1913-14, and was then bridge and road engineer for the Dominion Government at Waterton Lakes Park. From 1915 to 1919 he served with the Canadian expeditionary forces overseas, as captain in the 102nd battalion. On his return from the war he was superintendent and engineer of irrigation work for the Canada Land and Irrigation Co., and in the latter part of last year was appointed engineer for Lacombe Northwestern Railway.

OBITUARIES

HERMEGILDE DUFORT, a well known builder and contractor of Montreal, died at his home in that city on May 17, aged 71.

THOMAS C. ALLEN, a well known building contractor and former member of the Fredericton, N.B., city council, died in Bangor, Me., recently aged 66.

ECONOMIES TO HYDRO POWER USERS.

AUDITED figures summarizing the Hydro-electric business of five Ontario communities for the year 1921 have been given out by the Provincial Commission. Galt has a population of about 14,000; Fergus and Elora are well under 2,000 each while Rockwood and Brigidon are villages.

Galt became connected with the Hydro-electric system in May, 1911, and its first Hydro rates were only about half the charge before that date. These rates have been reduced from 5.3 cents to 1.8 cents for domestic lighting, and from 4.1 cents to 1.9 cents for commercial lighting. The industrial power rate has declined from \$17.77 to \$14.44. These reductions have had a direct money value to consumers of \$407,411.64. The load in 1912 was 425 h.p. For that reason the cost of delivered power has dropped from \$25 to \$21, despite increased generating costs at Niagara.

Fergus is 95 miles from Niagara Falls. Before the municipality began taking Hydro-electric energy in 1914 the kilowatt hour rate was 10 cents, with a meter rental of 25 cents per month. The first rates charged by the Provincial Commission averaged to consumers 6.8 cents domestic, 6.3 cents commercial, and \$29.25, per h.p. for industrial energy. Average rates last year were, respectively, 5.3 cents, 5.4 cents and \$23.17. The reductions have been made possible by the growing demand for service. The original load of 66.7 h.p. has increased to 185.1 h.p.

Elora paid before the advent of Hydro power 10 cents per k.w.h. with a monthly meter rental of 25 cents. The average Hydro-electric rates for 1915 were 7.4 cents and 7.1 cents, in 1921 they were 4.1 cents and 4.5 cents respectively. The industrial power rate is \$32.04. Through rate reductions authorized by the Provincial Commission the consumers in Elora have saved \$10,240.91. The load has grown from 49.3 to 197.5 h.p.

Rates in Rockwood have been successfully reduced since 1914, when they stood at an average of 8.8 cents per kilowatt hour. The present average is 6.4 cents for domestic lighting, 7.6c. for commercial lighting and \$28.17 per h.p. for industrial energy. The village is 88 miles from Niagara Falls and its population is only about 500.

Brigidon, with a population of about 500, is 234 miles from Niagara Falls and has been taking Hydro-electric energy since January, 1918. The original load of 21.9 h.p. has increased to 78.5. Former rates in the village averaged 15 cents per kilowatt hour.

The first rates quoted by the Hydro-Electric Power Commission averaged 9.5 cents for domestic lighting, the same for commercial lighting, and \$44.70 for industrial power. After four years' operation the rates are, respectively, 9.1 cents, 7.6 cents, and \$35.48. The saving to consumers even by these slight reductions has been \$1,738.

GEOLOGICAL FORMATION UNDER MCGILL UNIVERSITY

SOLID rock is being prospected for at various points on McGill University property at Montreal where buildings are to be erected during the course of the summer and fall. Six test pits have been sunk for this purpose. Four of them are on the lot at the southwest corner of Milton and University streets, where the new Mining, Electrical and Geological building is to be situated. Two others are in the "Hollow" between the Physics building and Sherbrooke Street, where the new gymnasium and residences are to be built. Another pit will also be sunk on this site.

An interesting fact is revealed by the work on the shafts at the corner of Milton and University Streets. In the pit nearest the mountain, the one on the north-west corner of the lot, bed-rock was reached at 14 ft. In the north-east pit, the one immediately at the corner of Milton and University streets, bed-rock was reached at 30 ft. In the south-west pit, near the Workman engineering shops, bed-rock was found at 33 ft. In the fourth pit, the workmen have reached a depth of 25 ft., and have not yet touched solid rock.

From these indications, it is evident that the site is directly on the edge of one of the "beaches" which geologists say form most of the territory of the central part of Montreal. The sudden descent from the 14-ft. pit to the 33-ft. one is proof that a cliff probably existed at this point at one time before the top soil was deposited. There is a succession of these beaches which lead in steps from the foot of Mount Royal to the Craig Street level, the formation of the territory between Craig Street and the river front not being quite so certainly established. The fall in level from Sherbrooke Street to St. Catharine Street, from Dorchester to Lagachetiere Street, and from that point to Craig Street, is due to the existence of these beaches which are hidden many feet beneath the surface by accumulated soil.

The pits in the "Hollow" where the students have played tennis for many years bring further proof of the location of the edge of one of the beaches. The north-east one behind the Forest Products' Laboratories, has been sunk to a depth of 29 ft. without any sign of bed-rock. The other one, to the south-west and near Sherbrooke Street, has been sunk to a depth of 39 ft. without encountering bed-rock. In both cases the presence of water has somewhat hampered operations, the workmen finding 3 or 4 ft. of water in the southwest pit every morning, and 13 or 14 ft. of water in the north-east one. Beneath the topsoil of loam and occasional pockets of clay and sand, the workmen reached a stratum of gravel and fine muddy sand, carrying a great deal of water. The gravel pebbles are very large, but smoothly polished. It is estimated that rock will be found at a depth between 50 and 60 ft. as the pits sunk for the piers of the McGill Union, which is immediately across the street, reached bed-rock at 60 ft.

Both the sites on which pits are being sunk are in the path of a stream which up till 50 or 60 years ago traversed the tract of land that James McGill bequeathed to found McGill College. This stream entered the property near the corner of Milton and University Streets, flowing towards the "Hollow."

The pits will be sunk until bed-rock is reached. They will then be used as piers for the new buildings. The University Street pits are being sunk by W. D. Lawrence and assistants, of the University engineering staff, while those near Sherbrooke Street are being worked by Fraser, Braco and Co. No shafts will be sunk for the Pathological building, which is to be built on University Street, above Pine Avenue, as solid rock is found at a depth of 2 ft. or 18 in. on this site.

At the annual meeting of the Quebec branch of the Engineering Institute of Canada, held on May 24 the following officers were elected: President, A. R. Decary; vice-president, A. B. Normand; secretary-treasurer, Hector Climon; Councillors, L. C. Dupuis and T. Rosseau.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders		Issue
	Close		
Toronto, Ont., installation of one four-million Imperial gallon centrifugal pump at Island Pumping Station....	June 13	May 9	
Ottawa, Ont., various work on Civic Hospital	May 25,		
	30, June 1	May 9	
Waltham, Ont., construction of dam.....	June 1	May 9	
Nassau, New Providence, Bahamas, dredging	July 15	May 9	
Edenwold R. M., Sask., road work.....	June 5	May 16	
Brant Tp., steel bridge and abutments ..	June 2	May 23	
London, Ont., construction of bridge ..	May 31	May 23	
Revelstoke, B.C., construction of bridge	June 19	May 23	
Welland, Ont., construction of water-bound macadam road; for oil, asphalt, Tarvia or other preservative of waterbound macadam roads	June 5	May 23	
Westminster Junction, B.C., construction of steel highway bridge	June 10	May 23	
Saskatchewan, Province of, construction of earth road from Wroxton west, 8 miles	May 31	May 23	
Saskatchewan, Province of, construction of earth road from Esterhazy to Stockholm	May 31	May 23	
Toronto, Ont., laying and jointing of water pipes	June 6	May 23	
Cobourg, Ont., construction of addition to school	June 2	May 23	
Olinda, Ont., construction of school	June 1	May 23	
Powell River, B.C., construction of addition to school	May 31	May 23	
Toronto, Ont., work on various schools ..	June 7	May 23	
Mimico, Ont., concrete and asphalt pavements	June 5	May 23	
Winnipeg, Man., work on Canadian National Railways	May 31	May 23	
Aurora, Ont., erection of addition to High School	June 6	May 23	
Ford, Ont., erection of school	June 1	May 23	
Montreal, Que., various work in erection of Notre Dame Hospital, Sherbrooke St. East	May 31	May 23	
St. Catharines, Ont., Sections 3 and 4 combined, Welland Ship Canal	June 9	May 23	

BRIDGES, ROADS AND STREETS

Berthier, Que.—Contract for construction of the Railton bridge in steel and concrete has been awarded to the Kennedy Construction Co., Ltd., Shaughnessy Bldg., Montreal, at \$19,820.

Birch Cliff, Ont.—Tenders will be received by W. D. Annis, Clerk, Scarborough Township, until 12 o'clock noon, Monday, June 12, for the construction of concrete sidewalks, together with the necessary grading, on following

streets: Danforth Ave., 38,940 sq. ft.; Kingston Road, 27,328 sq. ft.; Kildonan Drive, 10,580 sq. ft.; Eastwood Ave., 6,522 sq. ft.; Birch Cliff Ave., 2,100 sq. ft.; Audrey Ave., 3,850 sq. ft.; Pine Grove Ave., 5,732 sq. ft.; Park St., 1,032 sq. ft. Contractors may tender on any or all of the contracts. Plans and specifications may be seen at office of Township Engineer, Bank of Commerce Building, Birch Cliff.

Brampton, Ont.—Tenders will be received until noon, June 1, for construction of 24-ft. reinforced beam bridge on County road at Castlemore. N. L. Powell, Road Supt. of Peel County, Brampton.

Brantford, Ont.—City Council instructed City Engineer F. P. Adams to report on the paving of Ave. Road, from St. Paul Ave. to the city limits.

Chatham, Ont.—Contracts for concrete base course awarded by Council as follows: Lowe St., 1,200 sq. yds., to Western Construction Co., Chatham, at 69c per sq. yd. of base (labor only), and 18c for curb; Wilson Ave., 2,158 sq. yds., Western Construction Co., at 71c per sq. yd. and 18c per lin. ft. of curb; Ursuline Ave., 3,866 sq. yds., Geo. H. Conibear, Chatham, at 70c per sq. yd. and 20c per lin. ft. of curb; Cornhill St., 2,166 sq. yds., Western Construction Co., at 71c per sq. yd. and 18c per lin. ft. of curb; Adelaide St., 2,344 sq. yds., Geo. Conibear, Chatham, 70c per sq. yd. and 20c per lin. ft. of curb.

Edmonton, Alta.—S. E. Reagh, Engineer, has been engaged by the Edmonton Auto and Good Roads Association to survey and report on the route of the proposed Jasper highway from Evansburg to Entwistle and thence through to Jasper park.

Fort William, Ont.—Contract for road grading let by City Council to Geo. Hacquoil, 149 W. Amelia St., Fort William, at \$2.95 per yard. Other tenders received: City Engineer, \$3.25; A. Salo, 819 Alberta St., Fort William, \$3.00; F. Stewardson, S. Marks St., Fort William, \$3.30; F. Tondato, Fort William, \$5.40; J. W. Bain, 521 Wiley St., Fort William, \$5.00.

Goudreau, Ont.—Provincial Department of Highways has awarded contract to Lang & Sons, of Sault Ste. Marie, for construction of road here.

Guelph, Ont.—Contract for construction of concrete sidewalks has been awarded to Balconi and Battangalla, at 17c per sq. ft. and 19c per sq. ft. for crossings.

Haldimand Co., Ont.—Tenders will be received by Harrison Arrell, County Clerk, Caledonia, until 12 o'clock noon, Thursday, June 1, for construction of two concrete bridges. Consulting Engineers, Frank Barber & Associates, Toronto.

Kitchener, Ont.—Tenders for construction of pavement close May 30. S. Cassel, Clerk, Waterloo County, Kitchener.

Loiselleville, Ont.—Contract for construction of the Grand Marais Road pavement, Township of Sandwich West, has been awarded to Pettypiece, Ltd., Amherstburg, Ont.

Merrittton, Ont.—Lincoln County Council has granted \$50,000 to the town of Merrittton to pave the main street. Clerk, Richard Clark.

Montreal, Que.—City Council authorized purchase of 2,000 tons of asphalt from Imperial Oil Ltd., at \$15 per ton.

Montreal, Que.—City Council authorized purchase of 100,000 granite blocks from W. McNally & Co. at \$113 per thousand.

Montreal, Que.—Administrative Commission recommended to City Council that Clarke St. be paved from Bagge St. to Marie Anne St. at an estimated cost of \$29,727.

Montreal, Que.—City Council authorized construction of pavement on Wellington St., between McGill St. and the limits of Verdun. Following work was also authorized: \$1,050 for sidewalk on north side of Dandurand St., between Papineau and Cartier Sts., \$1,320 for sidewalk on both sides of Delorimier St., between Dandurand and Des Carrières Sts.; paving Hudson St., from Desery St. to the limits, \$5,689.75; \$9,112 for sidewalk on west side of Clarke St., between Kelly and Boisseau Sts.; \$5,765 for sidewalk on east side of Clarke St., between Kelly and Dick Sts.; \$500 for preparation of plan re widening Ontario St. tunnel; \$2,956 for sidewalk on Lasalle St., between Beau-bien and St. Zotique Sts.; \$1,656 for sidewalk on east side of Mentana St., \$4,378 for sidewalk on west side of Charlemagne St., from Masson to Rosemount Boulevard; \$29,727 for pavement on Clarke St., between Bagg and Marie Anne Sts.

New Brunswick, Province of.—Following contracts for construction of gravel roads have been awarded: Musquash to Lepreau, 6 miles, to Carlo Carmiel, of St. John, \$30,000; Meropis to Welsford, 5.3 miles, to Concrete Builders, Ltd., Fredericton, \$34,000; Buctouche North, 4 miles, Concrete Builders, Ltd., \$32,000; The Range to Cumberland Bay, 6.1 miles, Department of Public Works, \$12,000; Andover to Aroostook Junction, 6 miles, G. Hammond, Prince William, \$24,000.

Niagara Falls, Ont.—Tenders for the construction of a bituminous penetration road for the City of Niagara Falls Suburban Area Commission, on the Portage Road from the City Limits to Southend, and on the Chippawa Road from the city to Chippawa Village, consisting of a total length of 3,622 miles, will be received until June 5, addressed to H. H. Beam, Secretary of Commission. Plans and specifications may be seen at office of the County Road Superintendent at Welland.

Ontario, Province of.—Contract awarded to McGinnis & O'Connor, Kingston, to construct four miles of macadam base on the Kingston-Ottawa highway, beginning east of Kingston. The ten miles of roadway between Kingston and Gananoque built last year is to be surfaced with Tarmia at once.

Ontario, Province of.—Contract awarded to E. G. Law Co., Toronto, for patching and surface treatment of 9½ miles of road from Barriefield to the Finger Board. Curran & Briggs, of Toronto, have contract for building culverts at Washburn, and W. Holcroft, student, Queen's University, Kingston, has contract to build culverts at Elgin.

Pickering Tp., Ont.—Township Council appropriated \$25,000 to improve and open up new roads. Clerk, D. R. Beaton, Whitevale.

Revelstoke, B.C.—Tenders will be received until 12 o'clock noon, Monday, June 19, for the complete substructure of a bridge over the Columbia River, at Revelstoke. Plans and specifications may be seen at the office of the Government Agent, Revelstoke; Government Agent, Vancouver; and the Department of Public Works, Victoria.

Saskatchewan, Province of.—Stewart & Cameron, 238 Grain Exchange, Winnipeg, have been awarded the contract for construction of road from Fairlight East to the Manitoba Boundary, and for construction of road from Blenfait to Estevan. The total amounts of contracts were \$8,936.60 and \$6,096.35 respectively.

Saskatchewan, Province of.—Tenders will be received until 12 o'clock noon, Thursday, June 5, for construction of an earth road from Canora south to Burgis. Plans and specifications may be seen at offices of following: H. S. Carpenter, Deputy Minister of Highways, Regina, Wm. Grant, 810 Canada Bldg., Saskatoon; J. R. Reid, Court House, Swift Current; F. G. Kissack, Dominion Grain Co., North Battleford; A. R. G. Bomford, Sec.-Treas., R. M. No. 274, Canora, Sask.

Saskatchewan, Province of.—Tenders will be received until 12 o'clock noon, Thursday, June 8, for construction of an earth road from Kamsack north six miles. Plans and specifications may be seen at offices of following: R. S. Carpenter, Deputy Minister of Highways, Regina; Wm. Grant, 810 Canada Bldg., Saskatoon; J. R. Reid, Court

House, Swift Current; F. G. Kissack, Dominion Grain Co., North Battleford; G. B. Harper, Sec.-Treas., R. M. No. 271, Kamsack, Sask.

Scarboro Tp., Ont.—Township Council passed by-laws to construct sidewalks on Birchcliffe Ave., Kildonan Drive, Eastwood Ave., Danforth Ave. and Kingston Road. The grading of Audrey Ave. was discussed, and a scheme to lay a macadamized road for a distance of 5 miles in the southern end of the township was referred to the engineer to report as to probable cost.

Sherbrooke, Que.—Contract for supply of an 11 cu. ft. paving mixer for this city was awarded to the London Concrete Machinery Co., Ltd., of London, Ont., who supplied one of their Standard No. 11 pavers with steam engine and boiler.

Simcoe, Ont.—The county of Norfolk will continue the construction of the Port Dover to Brantford highway, by laying Tarmia, macadam penetration, 13 feet wide, and will do the work by day labor. Tenders received for this work were considered too high.

Toronto, Ont.—Board of Control decided to take the first step toward widening Bloor St. by adopting the plan for a homologated line on Bloor St.

Walkerton, Ont.—Tenders will be received by Fred B. James, Town Engineer, until noon, Monday, June 12, for construction of about 18,000 sq. yds. asphalt or bitulithic pavement on concrete base.

Wingham, Ont.—Contract for laying of approximately 2,500 sq. yds. of concrete pavement, together with necessary excavations and drainage, has been awarded to W. C. Brennan Contracting Co., of Hamilton, at \$2.85 per sq. yd., which includes grading, laying drains and all material.

Winnipeg, Man.—Tenders close May 30 for construction of granolithic walks on Argyle, Henry, Winnipeg, Owens and Greenwood Sts. City Clerk, C. J. Brown.

Winnipeg, Man.—The Provincial Government will proceed with road work authorized in 1920. Bonds amounting to \$430,000 will be issued to complete this work.

York Tp., Ont.—Contract for construction of six reinforced concrete culverts awarded to Ramsay Contracting Co., Toronto.

WATERWORKS AND SEWAGE

Kamloops, B.C.—City Council passed by-law providing for raising of \$17,000 for completion of sewer system. City Clerk, A. W. Jackson.

London, Ont.—City Council intends to construct a sanitary sewer on Florence St., from the old city limits to Oakland Ave., at a cost of \$21,975.15. City Clerk, S. Baker.

Long Branch, Ont.—At a conference between the Public Utilities Commission of New Toronto and Etobicoke Township Council arrangements were completed for the waterworks system here. It will extend from New Toronto to west boundaries of Long Branch Park and north to G. T. R. tracks. The water will be obtained from New Toronto Waterworks System.

Montreal, Que.—City Council passed by-law providing for a loan of \$250,000 for water works purposes.

Montreal, Que.—Administrative Commission recommended to City Council that a credit of \$48,542 be voted for construction of a sewer in Lavendure St., from Gouin Boulevard to 42nd Ave.

Montreal, Que.—City Council authorized construction of sewer on Lavendure St., from Gouin Boulevard to 42nd Ave. at a cost of \$48,542, also sewer on Nicolet St. at cost of \$6,481, for which contract has been let to A. Thezand.

Nelson, B.C.—City Engineer is preparing plans for construction of sewers in Fairview.

Niagara Falls, Ont.—Contract for supply of a 4-in. centrifugal sewerage pump for sump work for this city was awarded to the London Concrete Machinery Co., Ltd., London, Ont., and is being filled by one of their London-Aurora

pumps, fitted with electric motor and automatic sump control.

St. John, N.B.—Tenders closed May 29 for the supply of approximately 500 ft. of 16-in. 2,350 ft. 12-in., 1,300 ft. 10-in., 7,500 ft. 8-in., 2,000 ft. 6-in. and 1,000 ft. 4-in. cast iron pipe. Also approximately 16 tons of special castings. R. W. Wigmore, Commissioner of Water and Sewerage.

Sarnia, Ont.—City Council intends to construct a vitrified tile sewer on Davis St., from Palmerston St. to East St. at an estimated cost of \$3,118.09. City Clerk, M. D. Stewart.

Toronto, Ont.—City Council intends to construct water mains in Cedarvale Ave., Glenrose Ave., Heath St. and Rosewell Ave., at a total estimated cost of \$3,780.

Toronto, Ont.—City Council intends to construct concrete curbs in Burgess Ave. at a cost of \$770 and asphaltic concrete pavement and Hillside brick block pavement in Burgess Ave. at a cost of \$16,127.

Toronto, Ont.—Tenders will be received, addressed to the Chairman, Board of Control, until noon, Tuesday, June 6, for the construction of sewers in the following streets: Victoria St., Small St. and Walpole Ave. Specifications may be seen at the Works Department, Room 6, City Hall.

Walkerton, Ont.—James, Proctor & Redfern, Ltd., have been engaged by the Town Council to report on the cost of improving the waterworks system. The work will consist of increased reservoir capacity, pumping equipment and some watermain construction.

Windsor, Ont.—Tenders close May 30 for the construction of pavements on a number of streets. City Engineer, M. E. Brian.

Winnipeg, Man.—City Council intends to construct sewers in Hector Ave. and Assiniboine Drive, at a cost of \$4,487. City Clerk, C. J. Brown.

York Twp., Ont.—Contracts for construction of cast iron watermains awarded as follows: Avon Ave. and Windermere Place to W. E. Taylor; LeRoy Ave., Greenwood Ave. and Mortimer Ave., Ruscica Bros.; Hopedale Ave., Minton Place and Stanhope Ave., P. Mohan; Bungalow Road, Chilton Road, Pepler Ave., Pape Ave., Goodwood Park Crescent, Bala Ave., Hilltop Road, Second Ave. and Kenora Crescent, G. Thompson.

LIGHT, HEAT AND POWER

Ottawa, Ont.—City Council passed a by-law authorizing the raising of \$250,000 for the extension and improvement of the Hydro-Electric plant and electric distribution system. City Clerk, N. H. H. Lett.

Unionville, Ont.—Tenders close May 31 for construction of dam and spillway. Engineers, James, Proctor & Redfern, Ltd., Toronto.

Winnipeg, Man.—Contract for erection of switch house building for the Hydro-Electric System in Cornish Park let to Anderson & Wilson, 578 Agnes St., Winnipeg.

RAILWAYS

Kingston, Ont.—The Canadian Pacific Railway Co. has decided to build a spur line into the feldspar mining district, which is located near Thirteen Island Lake.

London, Ont.—That 85 miles of new steel rail will be laid in the London division of the Grand Trunk Railway this year is now considered a certainty, as the Dominion Government, in the railway estimates, has approved \$1,099,180 to be used for that purpose.

London, Ont.—London division's share of the Grand Trunk appropriations included in the railway department estimates approved by the House of Commons, Ottawa, include the following items for repairs and maintenance: Rails, \$1,099,180; bridges and culverts, \$20,200; floor, freight shed, London, \$5,000; signal department storehouse, \$2,600.

Montreal, Que.—Montreal Tramways Co. will lay

double-tracks from McGill St. to the Lachine canal at Wellington St. bridge.

Ontario, Province of.—Premier Drury announced that the Timiskaming & Northern Ontario Railway Commission has been instructed to make a report on the present system of the North Shore & Lake Huron Railway (the Bruce Mines line) and also on the feasibility of extending it northward.

St. Thomas, Ont.—J. J. Corcoran, General Superintendent of the Pere Marquette Railway, announced that the proposed improvements on the Canadian Division this year include the re-ballasting of the entire road-bed, work on which has already commenced. Other improvements planned are the replacing of ties and laying steel.

Walkerville, Ont.—Transportation Committee of Council decided to have a switch built on Walker Road.

Wallaceburg, Ont.—Pere Marquette Railway will start work about June 1 on the laying of 18 miles of new 85-pound rails between Wallaceburg and Sarnia.

FACTORIES AND LARGE BUILDINGS

Armstrong R. M., Man.—By-law will be submitted to ratepayers to authorize School District of Cossette, No. 1378, to borrow \$8,000 for erection of school. Sec.-Treas., G. H. Lavender, Inwood, Man.

Aurora, Ont.—Taylor Rubber Co., of Toronto, plan erection of plant, plans for which have been prepared.

Birch Cliff, Ont.—Bell Telephone Co. plans to expend \$1,000,000 on erection of Blackstone exchange on Main St. **Burnaby, B.C.**—School Board approved plans for erection of High School. Architects, McCarter & Nairne.

Calgary, Alta.—General contract for construction of memorial hall for G. W. V. A. awarded to Gauley & Vandenhoogen, and plumbing and heating contract to Snyder & Co.

Carleton Place, Ont.—On June 12 by-law will be submitted to ratepayers to provide \$100,000 for a new High School and site, and also \$10,000 for converting the present High School building into a public school.

Charlottetown, P. E. I.—Contract for construction of Prince Street School annex has been awarded to MacDougall & McAuley.

East Toronto, Ont.—New telephone exchange may be erected here.

Erindale, Ont.—Tenders were received by Chas. H. Page, Sec.-Treas., P. S. Board, until May 29 for erection of a concrete block and stucco public school building.

Ford, Ont.—Tenders for the erection of a public school will be received until noon, Monday, June 5. Plans and specifications may be obtained at the office of the architect, A. H. McPhail, McGregor Building, Windsor.

Fort Frances, Ont.—Tenders addressed to R. E. Mason, Architect, Fort William, Ont., will be received until 5 o'clock Saturday, June 3, for the construction of a High School Building, Fort Frances, Ont.

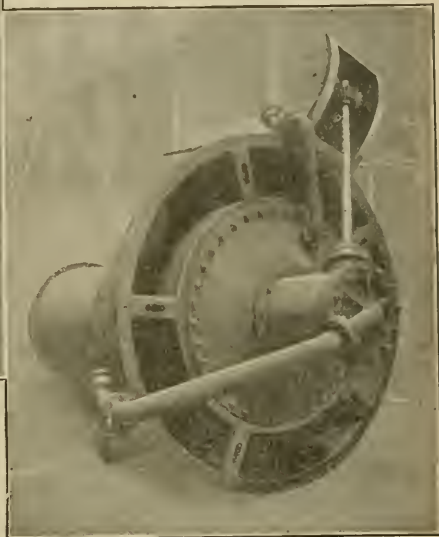
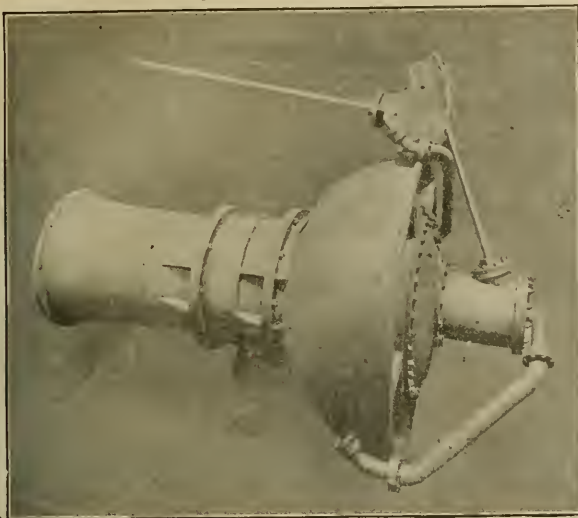
Fredericton, N.B.—Imperial Oil, Ltd., plan erection of warehouse and garage on Westmorland St., contract for which has been awarded to John Powers, of Odell Ave.

Galt, Ont.—Plans are under way for the erection of a \$100,000 office building on Main St. for the Freemasons of this city. Address Col. A. J. Oliver.

Hamilton, Ont.—Plans are being considered for the erection of an additional building on the city hospital grounds. Supt., Dr. Langrill.

Kamloops, B. C.—Contract for erection of Masonic Hall awarded to Robert McKay at approximately \$29,000.

London, Ont.—Actual construction of the first unit of the expansion program at Western University that will eventually mean the expenditure of \$2,000,000 in buildings for the Western and affiliated educational institutions, will be commenced shortly. The plans for the new art buildings are completed and these will be placed before the board of governors for approval at the next meeting. Tenders will be called as soon as possible after the plans receive the final assent of the board. As soon as work is actually commenced by the Western University authorities, steps will



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Philadelphia, Pa.: De Huff & Hopkins, Morris Building.

Cleveland, Ohio: Tomlinson Steam Specialty Co., Wade Bldg.

San Francisco, Cal.: Theo. F. Dregde, Monarch Building.
Western Representative

be taken towards the erection of the new Huron College buildings, it is expected.

Montreal, Que.—Permit issued to David Bros. for construction of a three-storey factory on Champlain St. at a cost of \$38,000.

Montreal, Que.—Plans for erection of new Anglican church for Cote St. Paul have been drawn by P. J. Turner, Architect. Approximate cost, \$35,000 or \$45,000.

Montreal, Que.—The construction of a new school for St. Clothilde parish on Sir George Etienne Cartier Square, in St. Henri ward, will be proceeded with in accordance with the plans of the Catholic School Commission.

New Westminster, B. C.—Exhibition Committee plan erection of new buildings at Queen's Park. Tenders will be called. President, Nels Nelson.

New Westminster, B.C.—Tenders, addressed to A. F. Proctor, Chief Engineer, Department of Railways, Victoria, B.C., for construction of a concrete retaining wall between the G. N. Railway and Front St., closed May 27.

Oakville, Ont.—Tenders will be received by C. F. Doty, Chairman, Building Committee, Oakville, until June 15 for additions and alterations to the Methodist Church Sunday School. Plans and specifications may be seen at the office of the Architects, Gordon & Helliwell, Confederation Life Bldg., Toronto.

Oshawa, Ont.—Following contracts have been awarded in connection with erection of McLaughlin Memorial Wing to hospital; Plumbing. W. E. Bramhall; heating, Miller & Libby; wiring; Canadian Electric Co., Toronto; fireproof stairs and fire escape, McGregor and McIntyre.

Ottawa, Ont.—Contract for construction of St. Luke's Anglican Church to Cooper and MacDonald, at \$42,182.

Ottawa, Ont.—Tenders close May 30 for erection of City Baths and Comfort Stations at corner of King Edward Ave. and York St. City Clerk, N. H. H. Lett.

Ottawa, Ont.—Time for receiving tenders for works connected with erection of Ottawa Civic Hospital buildings has been extended as follows: Plumbing, heating, ventilating and wiring in main building from May 25 until one o'clock, June 5; for power house, from May 30 until 2 o'clock p.m., June 13; for female help building, from June 1 until 2 o'clock p.m., June 15.

Owen Sound, Ont.—Permit issued to the McQuay Tanning Co. for erection of stone building 60 by 40 ft., three storeys, costing approximately \$10,000.

Ste. Anne de Beaupre, Que.—A church costing \$3,000,000 is to be erected here to replace the one destroyed by fire recently; also a monastery at a cost of \$500,000. A contest may be opened to architects carrying a prize of \$15,000.

St. Catharines, Ont.—Tenders will be received by Nicholson & MacBeth, Architects, 46 Queen St., St. Catharines, until 5 p.m., Thursday, June 1, for all trades required in the erection of a Temple for the Union Lodge of the Independent Order of Oddfellows.

St. Hyacinthe, Que.—Contract awarded by the Sisters of Charity of the Hotel Dieu to J. A. Durocher, of Montreal, for the construction of a hospital, at \$800,000.

St. John, N.B.—Provincial Government has been asked to authorize an issue of debentures amounting to \$230,000 for erection of school in West St. John, \$216,250, and foundation for Lorne School.

St. Thomas, Ont.—Committees of Alma College Board of Management have accepted plans of Architect Darrach for erection of gymnasium.

Sarnia, Ont.—Permit issued for addition to Central Methodist Church at cost of \$32,500.

Scarboro Tp., Ont.—Authority has been given by Township Council to School Trustees of S. S. 15 to raise \$40,000 to erect four additional rooms to School House No. 15.

Stamford Tp., Ont.—Trustees of Stamford High School accepted plans of C. M. Borter, architect, Niagara Falls, Ont., for an addition to the present school of four rooms and an assembly hall. Estimated cost, \$60,000.

Three Rivers, Que.—Fire destroyed the sawmill of Rouleau, Rocheleau & Dimontier.

Timmins, Ont.—Tenders, addressed to H. E. Montgomery, Secretary, Public School Board, will be received until Saturday, June 10, for a four-room addition to the Public School. Plans and specifications may be seen at the office of the Secretary, or of Ellis & Ellis, Manning Chambers, Toronto.

Toronto, Ont.—G.W.V.A. plan erection of memorial hall on Barrington Ave.

Toronto, Ont.—The directors of the Upper Canada Tract Society are considering the erection of a Sailors' Institute.

Toronto, Ont.—Plans have been prepared by Architect Langley for proposed new church building for Eglinton Presbyterian Church, North Toronto.

Toronto, Ont.—Erection of new Sunday School building and parish hall is planned in connection with St. Saviour's Anglican Church at Swanwick Ave. and Kimberley St., at a cost of \$18,000.

Toronto, Ont.—Plans for the new church building to be erected on the corner of Yonge and Heath Streets by Bloor Street Baptist Church are being prepared by Wickson & Gregg, Architects, Toronto.

Toronto, Ont.—Separate School Board awarded following contracts for construction of additional rooms at St. Rita's School: Carpentry, W. J. Madden, \$8,965; masonry, John T. Sullivan, \$15,375; plumbing and heating, W. J. McGuire Co., Ltd., \$9,759; plastering, E. J. Curry, \$1,750; painting, Jas. T. O'Hearn & Sons, \$1,048; electric wiring, Canada Electric Co., \$292; structural steel, Hepburn and Dishar, \$930; marble, J. G. Gibson Marble Co., \$2,275; galvanized iron, Beaver Roofing Co., \$597; metal ceilings, J. J. Glynn, \$1,150; mastic work, Vulcan Asphalt & Supply, \$469.

Toronto, Ont.—Plans for the \$90,000 six-room addition at Humber College have been approved and tenders will be called for shortly by Board of Education. Sketches for four rooms on the third storey at Runnymede School and for an addition of four rooms and a kindergarten at Kitchener School, each to cost \$75,000, have been approved. An addition of four rooms will be built at Bedford Park at a cost of \$50,000 and work on drawings is under way. Sketches for five rooms at Gledhill School have been approved by the Property Committee; an appropriation of \$100,000 has been made to cover the building of a new eight-room building on Bowmore Road to relieve Norway and Roden Schools; and a site is being bought for a similar addition to Morse and Leslie Schools to cost \$100,000. Four rooms will be built and two rooms finished at Kimberley School.

Vancouver, B.C.—Tenders, addressed to W. D. Harris, Secretary, Vancouver Harbor Commissioners, for electrification of Granville Island trackage, closed May 20.

Walkerville, Ont.—The Municipal Hospital which it is proposed to erect here will cost approximately \$100,000.

Waterloo, Ont.—An addition costing approximately \$30,000 is to be built to the Waterloo Theological College and Seminary.

Welland, Ont.—The erection of a Technical School is projected.

Welland, Ont.—E. Atkins awarded the contract to G. S. Pettit for the erection of a two-storey brick block on the corner of East Main and Burgar Streets.

Weston, Ont.—School by-law which involves an expenditure of \$115,000 will be submitted to ratepayers on June 3.

Whitby, Ont.—Erection of Fire Hall is planned. Clerk Albert W. Jackson.

Whitby, Ont.—Tenders addressed to Joseph King, Chairman, Board of Education, will be received until Thursday, June 1, for masonry, carpentry, painting, plumbing, heating and ventilation and electric wiring for alterations and additions to Dundas St. School.

York Tp., Ont.—York Township Council passed by-law providing for raising of \$155,000 to enable Board of Public School Trustees of S. S. No. 26 to erect a 12-roomed addi-

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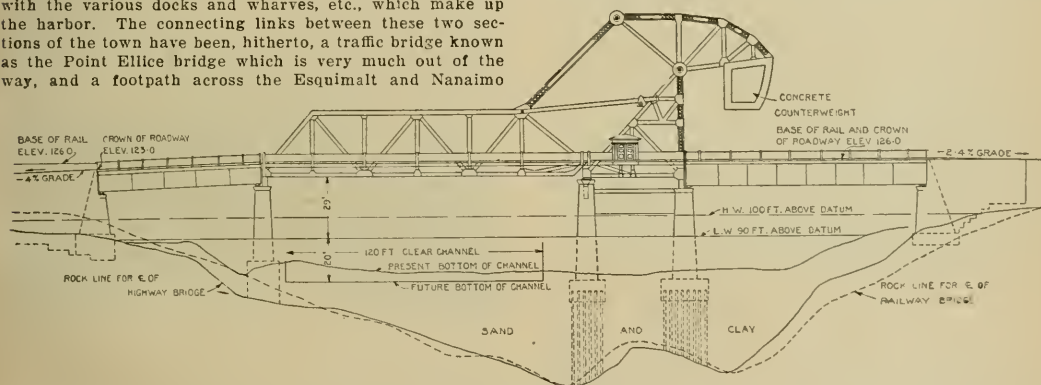
Substructure, Johnson St. Bridge, Victoria, B. C.

Central Single-Leaf Spans With Plate Girder Spans at Either End — Construction of Concrete Piers and Abutments — Details of Caisson Construction — Launching and Sinking Caissons — Pouring Concrete Under Water

By F. W. ALLWOOD,
Resident Engineer, Victoria, B.C.

ONE of the topographical advantages of the City of Victoria, B.C. is an inlet of navigable proportions which practically divides the town into two portions. On the western side of this inlet is located the large residential section known as Victoria West and also Esquimalt, the centre of the shipbuilding industry, while on the eastern side are the main business sections of the town together with the various docks and wharves, etc., which make up the harbor. The connecting links between these two sections of the town have been, hitherto, a traffic bridge known as the Point Ellice bridge which is very much out of the way, and a footpath across the Esquimalt and Nanaimo

one, and then to move the tracks back into their final position. It can be easily seen that a great deal of care had to be exercised in designing not only the foundations but also the steelwork which on the approach spans was eccentrically loaded. In addition to this the highway and railroad portions or the easterly approach spans diverged and the yard switches and curves for the Victoria terminal



ELEVATION JOHNSON STREET BRIDGE

Railroad bridge which is the most direct route between Victoria West and the city proper.

For some years it has been recognized that there would have to be, sooner or later, a bridge built on or near this latter site, but it was not until the winter of 1919-20 that the electors gave their consent to the expenditure of the \$720,000, which was the estimated cost of the completed structure.

General Layout of Bridge.

The general lay-out consists of two separate bridges for the highway and railroad respectively, built on the same piers with central single-leaf bascule spans capable of being operated as one, and with plate-girder spans at either end. The reason for building separate bridges was that the northerly or railroad portions of the substructure of the new bridge were found to be too close to the foundations of the old bridge for safety, and the use of this for railroad traffic could not be discontinued until after the erection of the new structure. It was therefore decided to build the southerly or highway portion first and then switch the E. & N. R. on to this portion, next to wreck the old bridge and complete the northerly half of the new

of the E. & N. R. commenced in the middle of the span, further complicating the stresses and rendering the whole design a matter of many heartaches.

Details of Substructure Units.

The substructure of the bridge consists of five concrete units namely: The east abutment, counterweight trunnion pier, main trunnion pier, rest pier, and west abutment. It was found possible to build only the counterweight trunnion pier, rest pier and west abutment completely, and the east abutment and main trunnion pier only in part. This portion of the work was combined in contract No. 1 and on tenders being called for, the city engineer's estimate by day labor being the lowest, he was instructed to proceed with the work.

The west abutment and portion of the east abutment in contract No. 1 were founded on rock and being for the most part above high water, presented no difficulties worthy of note. The counterweight and main trunnion piers however, were founded on piles driven to rock; timber caissons being used in their construction, some details of which may be of interest. The caisson for the counterweight trunnion pier was 94 ft. 9 in. long by 24 ft. 3 in.

overall, while that of the main trunnion pier was 68 ft. long by 17 ft. wide and in each case 45 ft. high. They were sunk into the mud a distance of 13 ft. by excavating



DRIVING PILES FOR MAIN TRUNNION PIER WITH STEAM HAMMER

inside the caissons and forcing them down by means of loaded sandboxes built onto their sides. The lower 13 ft. then of each caisson constituted the forms for the base of the pier and were therefore left down in the mud, being separable from the upper portions. They were built up to the twenty-fourth course on ships-ways after which they were launched and towed to the site where they were completed. These first thirteen courses consisted of 12 by 12 in. timbers laid horizontally with butt joints at the corners, and were drift-bolted at 5 ft. centres, staggered. Between the thirteenth and fourteenth courses, a joint was made consisting of pairs of angle irons, each pair being attached to the courses immediately above and below the joint, with the upstanding legs of the angles bolted together. Permanent cross frames were put in at 23 ft. 6 in. centres, and before pumping out the caisson, sliding frames were let down and wedged into position by divers, thus reducing the spans to about 8 ft.

Counterweight Trunnion Pier Caisson.

Owing to the spans across the ends of the counterweight trunnion pier caisson being 24 ft. 3 in., 12 by 12's



MAIN AND COUNTERWEIGHT TRUNNION PIERS COMPLETED

were not of sufficient strength to withstand the head of water on the outside of the caisson when it was pumped out, this head at high water being 30 ft. and it was found

cheaper to extend some of the side timbers and construct trusses to carry the load. Above the joints a very successful, if unusual, method was used to render the structure watertight. Two layers of jute rope were laid on the top of each course about 5 in. apart and an asphalt mixture poured between them before the laying of the next course. In addition, over each joint was laid on the outside a strip of canvas 5 in. wide held in place by a 1 by 3 in. batten spiked to the timber. This was found to be most efficacious, superior to caulking and far less costly. As an example of its advantages, while sinking the larger caisson, a thin crust of hard pan was encountered through which it broke causing the whole structure to topple sideways and take up a position of about 15 deg. to the vertical. This racked the caisson considerably and would certainly have been disastrous had caulking been used, but as it happened, no particular difficulty was experienced in pumping out. The strips of jute and asphalt filling also helped considerably by enabling the corners to be shimmed up and kept level, which would otherwise have been difficult owing to the lumber not always being sized exactly.

Caisson With Collapsible Bottom.

When the twenty-fourth course was reached, a collapsible bottom was built inside the caisson and about 5 ft.



CAISSON FOR MAIN TRUNNION PIER JUST BEFORE LAUNCHING

from the bottom. Pontoons consisting of 3 ft. diameter steel pipe about 18 ft. long each, were strung along the outside of the caisson at approximate water line. The whole structure was then launched in the ordinary manner. The collapsible bottom was constructed owing to the fact that there was not much water at the end of the ways and it was feared that the caisson would go aground, which would be avoided if the water percolated slowly through this false bottom, allowing the launching boat to pull the structure out to deep water before it filled entirely. The launching was a complete success in all cases and the method described is recommended.

After the caisson had been sunk and the excavation completed, piles were driven to rock, washborings being first taken and the piles cut off to the required length, which were sufficient to leave 5 ft. projecting into the concrete at the base of the pier. They were driven with a Union Ironworks steam hammer No. 1, with a follower, the average penetration being 40 ft. It was found necessary on several occasions to submerge the hammer, and some doubt was felt as to the wisdom of allowing cold water to touch the heated iron; for this reason air was tried, but was found far too expensive and steam was resorted to with no evil consequences.

Pouring the bases of the piers under water gave rise to the development of an underwater bucket, invented by F. M. Preston the city engineer. This provided for the



VIEW OF CONCRETE GUN FOR POURING CONCRETE UNDER WATER

concrete being lowered into place in a closed bucket under air pressure sufficient to balance the water pressure outside. A gate at the bottom of the bucket was then tripped and emptied by gravity. The resultant concrete was found to be excellent, far above the average quality of subaqueous work and with very little laitance on the surface.

Caisson For Rest Pier.

The rest pier was founded on rock and as it was impossible to employ a cofferdam, a caisson had to be used with a row of sheet piling driven around it. Unfortunately it was found that the rock on the northerly third of the site was some 12 ft. higher than it was on the southerly two thirds, making it an awkward proposition to get a caisson to fit even approximately. This however, was accomplished by building the southerly portion of the caisson up 14 ft. and then allowing the northerly portion to overhang for the remainder of the way up. On excavating, a bed of exceptionally hard clay and sand, almost a shale, was encountered immediately on top of the rock. This bed averaged between 3 to 4 ft. in thickness and



COMPLETING POURING CONCRETE FOR COUNTER-WEIGHT TRUNNION PIER

after trying several methods, the following was used with success. A high pressure water jet consisting of 2 in. hydraulic pipe with a nozzle flattened to about $\frac{3}{4}$ sq. in.

was suspended from the top and worked below by a diver. This gave about 100 lb. pressure at the nozzle and was found to break up this material sufficiently well to enable a clamshell bucket to handle it.

To avoid having to clear out the last few inches of mud from the rock, the sheet piling was driven about 3 ft. away from the side of the caisson which gave ample room for the dregs to be blown away by the jet from immediately under the base of the pier. It might be noted that this layer of shale was of sufficient hardness to obstruct the passage of the wash-boring apparatus so that considerable extra excavation had to be done.

At the time of writing, this entire contract amounting in all to over \$200,000 is all but completed, and it is of interest to note that a civic department has been able to undertake and carry out this work successfully, not only from an engineering, but also from a financial standpoint.

EXPENDITURE ON LINCOLN HIGHWAY.

STATISTICS furnished by the Lincoln Highways Association, which has been promoting the development of this highway since 1913, show that 397 miles of new construction were completed during 1921 at a cost of \$7,737,473. Maintenance during 1921 cost the States and



PLACING CONCRETE UNDER WATER, REST PIER BASE

counties through which it passes, \$1,735,433, so that the total expended on Lincoln Way betterment was \$9,472,906. The additional mileage improved last year represents 12 per cent. of the total mileage.

The expenditures on Lincoln Way improvement in 1921 brought the total expended on this great national traffic artery since the dedication of the route in 1913, to more than \$40,000,000, or more than twice what was originally estimated would build the Lincoln Highway from coast to coast.

The marking of the Lincoln Highway was finally completed in 1921 when, with the co-operation of the New Jersey State Highway Department, the last permanent signs were placed along the 60-mile link between Jersey City and Trenton. The balance of the marking done in 1919 and 1920 has been well maintained, with the result that a uniform marking system now extends from the Hudson River to the Golden Gate. The Lincoln Highway is the best marked road in America and this system, installed at such great expense, is a wonderful aid to through traffic.

Messrs. Royce Limited, Manchester, Eng., have received an order for four Royce standard three motor overhead electric travelling cranes, each of 40-tons capacity and fitted with a 10-ton auxiliary lifting barrel. These cranes are for service in India.

HIGHWAY TRAFFIC CENSUS*

Character of Traffic Controls Highway Design — Tendency
Towards Lighter Vehicles — Limitations to Traffic
Census — Main Purpose of Census

By J. Gordon McKay,

Professor of Economics, University of Wisconsin.

HIGHWAY design must necessarily be based upon traffic, and the behavior of the various details of design observed under different ranges and types of traffic. Highway transportation is in a condition of flux. An immense growth may be anticipated in the next decade. Our rapidly growing mileage of completed highways, with the prospect of continuous increase each year of construction programs, emphasizes the urgent need for road information upon which to base sound, economical road building policies, that we may avoid the mistakes and disasters of unwise financial methods and unsound construction policies. The solution of engineering problems of design, maintenance, and the like, depends largely upon the character of the traffic, its speed, and the unit loads the highway must carry. The true purpose of an improved highway is a high degree of transportation service at the least cost to the public and road user. Clearly a traffic census is not a panacea, but without a knowledge of the actual traffic, speed, type, and weight, of a given area, we are working in the dark. The actual traffic, in terms of volume, density, speed, and unit weights, must be correlated with laboratory and experimental impact tests as a guide to rational design. Independently each type of research is valuable, but the true worth of both cannot be realized until combined. In other words, interpreting the results of laboratory experiment in terms of vehicles on the highway.

Heavy or Light Vehicles.

Our state and national investments in highway systems is constantly increasing. The investment in motor vehicles and the automotive industry is growing steadily. A careful analysis must be made of the chief traffic elements responsible for increased construction and maintenance costs before the enactment of legislation which may, while protecting the highway, prove injurious to the growth of highway transport service, and detrimental to the automotive industry. We must be certain of our facts before we limit the traffic which may pass over any given highway. The limitation of wheel and gross loads must be based on definite information. The rapid destruction under heavy traffic does not necessarily mean that the construction of more durable pavement types is essential. It is conceivable that the heavy freighting vehicle is not an economic unit load, and that ultimately a smaller unit will become the maximum, but first we must have proof obtained by impartial research.

In making comparisons of the economies of the different methods of freight movement we are prone to make comparisons on the basis of operating costs alone. The true haulage cost must be based not only upon the cost of operation of the vehicle, but also a portion of the cost of building and maintaining the highway for the movement of vehicles, and must be included as a cost charge. Naturally this cost increases rapidly as the unit loads increase. Saving in transport costs may occur when heavy vehicles operate, reducing the freight costs by a few cents per ton mile. On the other hand, a decided economic and social loss arises when new roads must be built, or maintenance costs are excessive due to the utilization of the highway by heavy vehicles. The savings in operating costs of a few cents per ton mile are more than offset by the heavy construction and maintenance charge. It is not alone a question of cost, but the road is out of service which is even more serious.

It may be that increase of tire width per capacity trucks to carry the freight load without destruction of the pavement. A study of the comparative economies of three, five and seven ton trucks with regard to highway construction and maintenance, vehicle operation costs, and service time, would settle this controversial point and determine the maximum economical lead unit.

It does not appear that the use of pneumatic tires is a possible solution, limited to use on small capacity trucks, and prohibitive in cost.

Today we see a strong tendency in the direction of restrictive legislation limiting the total loads which may pass over our highways and bridges. We must be careful and sure of the facts upon which such legislation is based, and injure the transport value of a given highway which such legislation is attempting to conserve. The classification of a highway system which limits the gross weight to twelve and a half tons on a very small percentage of the roads of a state, and to seven and one half tons on the balance of the state system definitely limits the sale area of the manufacturer of larger capacity trucks. It is to the truck manufacturers' best interests to cooperate in the solving of his difficult problem in order that his market may not be restricted beyond reasonable limits. The establishment of weight limits per inch of tire width must be based upon conclusive evidence and research, and not mere belief.

The manufacturer of trucks cannot afford to design and market vehicles which unduly increase the cost of construction and maintenance of our highways. The highway engineer cannot afford to build roads that will cripple or limit unduly the hauling capacity of trucks. There is a joint enterprise, the movement of the maximum traffic at a minimum cost, and upon its successful solution rests the welfare of both the public and the vehicle manufacturer.

Motor Trucks Versus Railroads.

It is an open question whether or not the ultimate sphere of motor truck operation is to be competitive with or supplementary to our existing transport system. The consideration of this problem carries with it far reaching consequences, beyond a mere comparison of the cost of movement of freight by one or the other type of carrier. The movement of freight is by nature monopolistic and does not permit of true competition. Either one or the other type of transport will occupy the field. The possibility of junking our railroad investment due to motor truck competition would involve the destruction of property rights representing approximately one-twenty-fifth of our national wealth. We must consider the relative difference in the investment, comparing a large railroad system with strict governmental regulation of rates and service, with fleets of motor vehicles, in which the investment of the owner is small, with an absence of rate regulation or guarantee of service. The railroad investment is permanent and cannot move to an alternative field; it must operate or become a loss. The commercial vehicle operator, however, may move to alternative fields when profits fall. This naturally would endanger the guarantee of freight service which is a more fundamental question than cost. It is difficult to conceive of a movement of heavy freight of low value by truck transport. The cost of moving such products as coal and iron, practically limits the commercial truck field to high value and low bulk goods. Can the railroads operate profitably moving the low value and large bulk commodity goods on the short haul, while the profitable business is absorbed by the motor vehicle? Any comparison of the two types of transport with a view of selection of the more economical type involves a comparison of costs. In such an analysis we must not forget that the cost of construction and maintenance of the road bed in both cases, is a part of the charge which must be made against the freight moved. A proper share of construction costs and maintenance costs of the highway right of way must be paid by the truck operator, before a real comparison of rail and truck rates can be made.

A clear analysis of all the factors involved must be made before we can determine whether the field of truck

* Paper read at the American Road Builders' Association Convention, Chicago.

operation as a carrier is to be competitive on the short haul, long haul, both, or supplementary to existing transport systems.

Unprejudiced research is fundamental in the attempt to solve these many difficult highway problems. Supply definite information to highway engineer that the type and weight of traffic will not change over night, and he will build safely and permanently roads able to carry the traffic at a cost not exceeding the service value of the highway to the community. The vehicle manufacturer in all fairness is entitled to know the facts upon which he must design and build trucks which will meet the requirements of the constantly increasing highway legislation.

In approaching an analysis of some of the factors involved in highway construction and maintenance, and motor vehicle movement, a clear picture of the traffic passing over a given highway is essential to a thorough understanding of the type of construction necessary for traffic of a given type, giving at the same time a definite idea of the regularity of motor vehicle movement, density, weights and produce.

A traffic census may be defined as "a complete summation of traffic passing over the highways of a given area during a definite period of time."

Traffic Census Limitations.

Every traffic census has certain limitations and a traffic census based on the following plan has the following limitations:

1. A certain portion of the traffic over newly completed roads consist of "attracted" traffic from other routes, and does not represent the true traffic which will ultimately pass over the particular highway observed. Allowance must be made for re-distribution of traffic when parallel highways of the complete system are constructed.

2. We cannot expect that a summation of vehicular movement will accurately portray future traffic. To obtain a picture of future traffic the census must be taken at given intervals of time over a period of years to determine the percentage increase of each vehicle type. The potential traffic of a given area to supplement the actual traffic census may be obtained by a survey of the agricultural and industrial growth of the community.

3. Only in a general way will the census data answer the question of the influence of various types of traffic on the highway without maintenance studies of the same road, correlated with impact studies. To be able to interpret correctly the weight and volume data, accurate maintenance cost studies are essential. It is advisable in the selection of traffic census stations to place them on highways on which maintenance costs of the various types of pavement are kept.

4. The tonnage volume and weight per capacity of various vehicles will be more valuable when combined with impact studies showing the effect on different types of pavement by impact tests. Being given the result of impact studies on several road types, produced by the different vehicles as shown by the census, the construction engineer can be assured of the type of highway he must build to carry the traffic. This will prevent over or under-construction with the economic wastage occurring in either case.

In the past, traffic censuses have been taken by state highway departments largely for the purpose of determining the number of vehicles, passengers and types to indicate numerical movement. Generally such survey occurred during density of movement and for short periods of time. In a few cases the period of the survey was longer, while in one case actual weights were recorded.

Main Purpose of Traffic Census.

In the belief that the expense of taking traffic census should produce more than surface results, and that the importance of the problems involved, calls for definite information, the following outline of a traffic census is evolved.

The main purposes of a traffic census may be summarized as follows:

1. An aid in determining the economic value of a highway. Three principal factors enter into the valuation of a highway improvement. The increase in land values, highway service value in terms of passenger and freight ton miles, and the general value to a community. The only method of obtaining passenger and freight ton miles, is by means of a traffic census for a definite period, translated into yearly traffic.

2. Classification of vehicular traffic. A classification of traffic of the several types is useful in formulating traffic regulations, and to some extent in determining the percentage source of revenue from highway users in accordance with their actual use of the highway.

3. To determine gross truck weights, overloading per truck capacity, and wheel loads. Weight and speed are guides to design, pavement selection, limitations of grade and alignment. The facts as to overloading per capacity can only be determined by a knowledge of front and rear axle, distribution of weight in terms of loads per inch of tire width. It is not merely a problem of loads beyond a given maximum, but the real difficulty lies in overloading beyond truck capacity.

4. Distribution of construction and maintenance funds. To distribute maintenance and construction funds in a fair proportion to traffic, we must know the volume and type of traffic on the different highways. The greater the volume the traffic, logically the greater the percent of construction and maintenance funds allocated.

5. To determine traffic density and truck body widths. The peak of traffic, hourly, daily, and during the season is essential. Peak density and speed influence width of pavement and determine the maximum width necessary to carry the peak load. A direct ratio exists between vehicle body widths and pavement width. Pavement width increases with the increased speed movement of the vehicle, particularly when the load is heavy.

Seasonal and yearly traffic volume and density enable a prediction in a general way of future traffic.

6. To determine the vehicular movement of freight.

Information as to regular and irregular trucking lines throws light on the proportion of regular freight movement. This is particularly valuable in the industrial states of the east and northeast.

The average length of haul of commercial freighting indicated the field of competition of the truck and the railroad, whether the short or long haul. The average New England haul is forty-seven miles.

The type, volume, and value of commodities moved indicate the commodity competition and the percent of high value and small bulk freight moved as compared with low value and large bulk freight.

The average delivery time indicated the rapidity of movement of commercial freight service.

Information relative to truck operating costs and freight rates does not properly lie in the field of the traffic census, but must be made through independent studies.

7. Average speed of vehicles.

This data must necessarily be obtained at the same time the census is recorded to check each vehicle observed in the speed test with the data obtained at the census station. The recording of the license number in each case permits the determination of capacity and weight. This information is useful in the formulation of speed regulations and their enforcement.

8. Basis of the formulation of traffic regulations and their enforcement.

The information as to weight, overloading, tire condition, body widths and speed not only afford a reasonable basis of traffic regulation, but is the data upon which enforcement depends.

Connecticut Traffic Census.

With these purposes in mind a comprehensive study of highway traffic was conducted in the state of Connecticut during August and October of 1921 by the Connecticut

Highway Department in co-operation with the Bureau of Public Roads. This survey consisted of two traffic census conducted on two of the principal highways of Connecticut according to a plan I had outlined as the basis of a model traffic census, and was put into operation by Highway Commissioner Bennett of the State of Connecticut. Each survey covered a period of two weeks, and included two night surveys to determine the percent of night movement. Scales were installed by the Connecticut Highway Department on the roadside by means of which the actual weights of trucks were obtained.

A passenger car schedule which was drawn up, enabled a classification to be made of makes of cars, cylinders, number of passengers, and the license number data to determine the percentage of inter-state vehicular movement. The start of haul and end of haul made it possible to determine actual mileage. This was important since knowing the number of passengers carried by each car and the mileage for each car we could determine the passenger miles and arrive at an estimate of the passenger transport service of the highways on which the census occurred.

The truck schedules were divided into two parts. The first dealing primarily with weights, body widths, makes, and tire conditions while the second schedule included capacities, consignor and consignees, and commodity loads. The first schedule gave the weights, distributed between front and rear axle which were the basis of the overload study. The width of tire was taken at the same time enabling a study of loads per inch of tire width.

A second truck schedule enabled a study of commodity movement, and mileage, and whether regular or irregular movement of freight. The origin and destination of commodities make possible a study of the distribution of goods from points of origin to points of distribution, by cities, making it possible to compare the movement of goods by truck with railroad movement, having the commodity movement, and net tonnage of each class of commodities, the truck tariff and railroad tariff to the same points of distribution may be compared. Finally the type of commodity moved, and its volume, permits a comparison of the gross tonnage with the railroad classification, showing the difference in the principal types of commodities carried by rail or by motor transport.

DESIGN OF POWER CANALS, HEADWORKS AND SURGE TANKS

IN the symposium on hydraulics held last March at the University of Toronto under the auspices of Prof. Angus of the Faculty of Applied Science, the fourth lecture was given by T. H. Hogg, assistant chief hydraulic engineer of the Ontario Hydro-Electric Power Commission. Mr. Hogg's address covered the general features of intakes, canals and surge tanks. Owing to the limited time at his disposal, the speaker was able to deal only in a general way with the various subjects under consideration, but succeeded in conveying to a most interested audience the function and requirements of the canal and surge tank in a power development.

In dealing with intakes and ice protection it was pointed out that an intake performs the dual function of providing a means of control for the water and also of preventing the entrance of ice into the canal. Various forms of intakes were described, including the ones in the existing plants at Niagara Falls and the proposed intake for the Chippawa-Queenston development. In dealing with the latter the speaker pointed out that this structure provides two forms of intake, one the ordinary open type with breast wall for use when there is no ice in the river, and the submerged type for use with ice flowing and consisting of six tubes on the river bottom, with slots in each so arranged as to have a draft throughout their length proportionate to the amount of water intercepted by them.

Mr. Hogg also pointed out different means for combatting ice, which, he stated, forms a greater problem in

plants in moderate latitudes than it does in plants in the extreme north where an ice cover forms early in the season and lasts until the spring break-up.

Headworks were differentiated from intakes as meaning the entrance to pipe lines or conduits, whereas an intake was described as being the entrance to a canal or forebay. In dealing with headworks the speaker pointed out the advisability of securing uniform flow over the entire rack area in order to avoid high velocities at centralized points as often occurs with the ordinary design of headworks. He cited the provision being made at the Shawinigan Water & Power Co's plant for securing uniform draft at the entrance to their new 22-ft. diameter pipe line. The advantage of racks designed in independent and replaceable units instead of being built up as continuous structures was also pointed out, and the many failures, with consequent shutdowns, were mentioned to impress the importance of this feature.

Concerning canals it was pointed out that while the theory of flow in channels is all based on uniform flow, this is a condition that rarely exists in actual practice; the method of investigating backwater and drop-down curves was mentioned but not dealt with, as this subject is included in the University lectures on hydraulics.

It was pointed out by the speaker that within limits the slope of the bottom of the canal has very little effect on the discharging capacity, and that alignment of the sides and bottom of a canal are of more importance in securing discharging capacity than the smoothness of the surface in contact with the water.

The speaker pointed out the danger of using theoretical values and formulae without giving consideration to the assumptions on which these are based. As an example he cited the case of a channel in rock, the most efficient section of which is given in all works on hydraulics as having a width twice the depth; this is economically true only when the ground line coincides with the water surface, and must be modified as soon as there is any overburden to be considered. This factor, however, is not usually pointed out in text books, and is apt to be overlooked by one whose experience along this line is limited.

The function of the surge tank for regulating long pipe lines was clearly outlined by Mr. Hogg, who showed how in the case of the differential tank that the immediate demands of the turbines are supplied by the stored water in the tank, while the drop in the internal riser causes a quick acceleration of the water in the pipe line. The difference between a differential tank and a simple tank was pointed out, and the application of a process of arithmetical integration to the investigations of the surges occurring in these two kinds of tanks was explained, and the various factors to be considered were enumerated.

The application of this method of investigation to other problems such as water works intakes and pressure rise in pipe lines, was shown by Mr. Hogg; also how all consideration of velocity changes in conduits is based on Newton's "Second Law of Motion." He developed the acceleration formula for pipe lines in the following way:

$$F = Ma \text{ (Newton's second law).}$$

$$M = AWL/g = \text{mass of water in conduit,}$$

$$a = dv/dt = \text{acceleration.}$$

$$F = AWha = \text{accelerating force acting on the water column.}$$

$$AWha = (AWL/g) (dv/dt).$$

$$dv/dt = gha/L,$$

$$\text{where } F = \text{force}$$

$$M = \text{mass}$$

$$a = \text{acceleration}$$

$$ha = \text{accelerating head}$$

$$g = \text{gravitational unit}$$

$$w = \text{weight of a unit mass of water.}$$

By the use of this formula the speaker showed the drop in the gradient of a pipe line due to a sudden acceleration of velocity, and pointed out the necessity of investigating all pipe lines for this condition in order that a sudden change in load would not draw the gradient below the top of the pipe with the ensuing possibility of collapse.

SAFETY AND BEAUTY IN THE LAYOUT AND DESIGN OF HIGHWAYS*

Eliminating Hazards in Highway Travel — Value of Attractive Routes — Construction of Curves, Detours, Bridges — Trees Offer Effective Relief.

By A. R. Hirst,
State Highway Engineer of Wisconsin.

HIGHWAY officials who were concerned in the design and construction of highways prior to 1900 were fortunate in that they had to pay little attention to many factors which now very materially complicate the design of modern pavements. It was sufficient then to grade and drain a highway well, and place a macadam surface of narrow width; about the only element of risk being the danger at grade crossings with railroads. Traffic was light and slow moving. At that time a horse vehicle travelling at the rate of twenty miles an hour was a meteor, and a heavily laden wagon an element of destruction.

In designing highways for present day traffic, the engineer is confronted with a much more intricate problem. Not only must we design highways which will withstand traffic, but we must also design them so as to be safe and aesthetic.

We are designing and building highways, many of which have a traffic of over ten thousand vehicles on certain days, and any road considered even of minor importance is carrying traffic of four or five hundred vehicles daily. This traffic is moving very rapidly, and much of it is very heavy and also moving rapidly.

For some years yet the increase of motor vehicles is probably going to be greater in percentage than the rate of construction of adequate highways. The manufacture of trucks and automobiles has by no means reached the limit. We will undoubtedly see automobiles radically cheaper, and motor trucks even more materially reduced in price. I am willing to risk the prediction that fifteen years from now practically every American state will register double the number of motor vehicles that it registered in 1921.

Regardless of the growth of motor vehicle traffic in the future, the amount of which we now have is sufficient to make the subject of the safe design, construction, and maintenance of highways of the greatest importance.

The construction of a modern highway is the building of a transportation artery and in its design we should fully consider all transportation factors involved. The bare factor of getting traffic over the road so that it does not mire in the mud or break down is a small part of the whole. Traffic should be enabled to move comfortably, safely, and rapidly without danger either to itself or to other vehicles using the same road.

Too many of us have plodded along in the old ruts, building just highways, when we should have been building arteries of traffic. We seldom stop to think that more passengers and freight are carried on our principal highways than on many important railroads. Railroad tracks are not merely built to bear the weight of trains, but they are so designed and constructed that trains can move expeditiously and safely, and every precaution is taken to prevent accidents. If it was good public policy to force the railroads to tremendous expenditures for the safety of railroad traffic I can see no reason why it is not equally good policy for the public to protect its own by building really safe highways.

Layout of Systems.

The first and best chance which a state highway department has of eliminating hazards in highway travel, is in the original layout of the highway system which it expects to build.

The great majority of American States are now fairly well provided with strips of land set aside for highway

purposes. Those states which have made comparatively little progress in the construction of modern highways have, in these lines of travel, more or less undeveloped, the routes of their final highway systems. In laying out the various highway systems such as federal systems, state systems, and county systems, it is possible by careful preliminary work and investigation in establishing the approximate future course of these highways, to eliminate very considerably the present hazards, without expending anything but brain work in making the eliminations.

In Wisconsin, in laying out the state trunk highway system, it was possible for us to eliminate a large number of grade crossings with railroads, heavy grades, right angle and other dangerous curves, and other hazards without spending a dollar in construction but by simply selecting routes other than those which had been previously followed. If we had this work to do over again we would be much more radical in making new routings.

Another factor which should be considered in the layouts is that of making accessible or visible any feature of the landscape or topography which is extraordinary, beautiful or attractive. Weight given to the selection of routes which are attractive, scenically or artistically, rather than purely utilitarian will vary very much in accordance to the area traversed and the country served. Those States which are intending to capitalize and encourage tourist traffic should pay a very considerable attention to the factor of having their roads run, wherever possible, where the scenery is attractive or where lakes, rivers, mountains, forests, etc., can be set out well and made fully accessible. In States which have not these features or in parts of States where these features are not present, there should be the strictest adherence to utilitarian practice in selecting the shortest road which will carry traffic safely and cheaply.

We have found, by sad experience, that any effort to serve two purposes with one road or to compromise on locations is a fatal mistake. Serve those purposes which should first be served with the right road, and if there is not enough mileage to go around, serve the other purposes with the right road later.

Design.

It is in the design of highway structures that the greatest advancement can be made towards securing both safety and beauty. Up to the present the principal idea of American highway engineers has been to build a structure which would stand up under traffic. Not only has very little attention been paid to the artistic, but in many cases very little attention has been paid to safety. Practice along safety lines is, however, making rapid advances as traffic gets heavier and faster.

Curvature.

A large proportion of the accidents on highways take place at curves, both vertical and horizontal, and it is at these critical points that probably the greatest advance in the art of highway design can be made.

It has recently been stated that more accidents occur on highways without curvature than occur on curving and supposed to be dangerous highways. I doubt if this is true. If so, it is undoubtedly due to one or both of two causes; (a) too narrow widths of surfacing; (b) the presence of more traffic on the straight away stretches than on the sections with excessive curvature. I doubt not that if the exact number of vehicles and of accidents were known, that in practically every case the road with the sharpest curves would show the most accidents per mile of traffic. Any comparison of accidents without a comparison of traffic is absolutely worthless.

Vertical curves are almost as dangerous as horizontal curves, especially if the surfaces are narrow and the drivers do not keep to the right side of the road on approaching the crown of hills. Vertical curves should have a radius of at least 1,000 ft. With this radius an approaching vehicle can be seen 200 ft. ahead, and there is comparative safety with even moderately careful driving.

*Paper read at the Annual Meeting of the American Association of State Highway Officials, Omaha, Neb.

Unless the circumstances are very exceptional, on high speed main lines of travel, no horizontal curves of less than 300 ft. radius should be planned, and on roads of the very highest character of traffic almost any expenditure is justified in order to get such curves or even easier ones. A 300-ft. radius curve in a cut gives vision only 200 ft. ahead and this is little enough when two cars going thirty miles an hour will meet in two seconds after seeing each other.

Curves should, of course, be super-elevated and widened. This practice is now general in the several states, and while in most cases it has not proceeded far enough, more radical super-elevations are being used each year. It is our opinion that on curves less than 300 ft. in radius, super-elevations up to 1 in. to the foot are desirable. All curves of less than 1,000 ft. radius should be widened, the widening being greater as the radius of the curve becomes smaller. If radii as small as 300 ft. are used, the widening should be to at least 24 ft.

Where it is impossible to get curves with a radius of 300 ft. or more, if such a case exists, care should be taken to secure at least 200 ft. of vision ahead. Too many engineers are placing their curves so as to restrict the vision, when it is possible by throwing the ends of the tangents away from the bank to put in the same curve and still get vision past the bank. Bank cutting down to the line of vision is being practiced to some extent, but unless good maintenance is secured this is not as satisfactory as was expected.

Dead ends come under the same classification as curves. Dead ends are corners where the course of the main highway is not continued by an inferior highway, while the main highway makes a sharp turn. Treatment at such places should be just as radical as at curves, and added protection should be given by erecting white boarding across the dead end so that the driver is notified that the highway turns sharply. On such boards an arrow indicating the direction of the turn is helpful.

Something might be said about the acquirement of the inside of curves so as to keep the ground on the inside in low growing crops. In few cases is this necessary, because if the farmer is restricted as to what he can grow or build on a certain area, the same area might just as well be bought and the road located so that the proper curve protection is built in the structure itself.

The writer wishes to emphasize that the points of danger on our highways are at curves, and on high speed main lines of traffic too much money cannot be spent in securing good vision by building curves of easy radius. The fact that in every case an easier curve shortens up the centre line distance and thus reduces the amount of paving required, always helps to offset the additional cost of securing right of way for such curves, and if the highest class of pavement is being built, the saving in pavement often goes a long way towards paying the extra cost of an adequate curve.

Widths of Highways.

After curves, probably the factor producing the most danger and accidents is narrow surfacing. No permanent roadway should be built of a width less than 18 ft. on any main line of travel, and that 20 ft. is a much better and safer width. The writer does not believe in going over 20 ft. unless a width for four lines of traffic is desired, in which case 36 ft. should be the minimum, and 40 ft. would be much better.

It is the writer's opinion that on high speed roads pavements should be built in multiples of 10 ft. That is, 10 ft. should be provided for each line of traffic. It is also the writer's opinion that the so-called bastard widths are always dangerous. Such widths as 14, 15, 16, 24, 32 ft., and any other widths which do not provide a clear width of at least 9 ft. for each line of vehicles sought to be accommodated, are bastard widths and should never be used.

Large amounts have been wasted, or partially wasted, in building 14, 15 and 16-ft. pavements. If the traffic does not justify at least 18 ft., it is our opinion that a 9 or 10-ft. road should be built so that no one will be deceived

into believing that there is a double track road when none, in fact, exists. Such roads can be made double track roads later when funds become available.

In addition to the fact that wide roads are safer, they are also easier and cheaper to maintain, in that they keep the traffic off the edges of the pavement, and also provide for a moderate distribution of traffic.

Bridges and culverts should be built of adequate widths between endwalls. The distance between endwalls should be at least the width of the top of the fills when new. On main lines of travel not less than 26 ft. should be used as the distance between endwalls or parapets of bridges and culverts, and if the grades are wider, greater widths should be provided.

In the design of bridges and culverts, especially in the endwalls and railings, there are great opportunities for the beautification of highways. Artistic paneling or spindles add very materially to the appearance of concrete structures without adding materially to their cost. People are willing to pay for the artistic when they once have a sufficient number of samples of artistic bridges from which to judge the effects of good proportions and good design.

There is room for more artistic development in guard fence rails and in the construction of guard fences. Nothing probably adds more to the appearance of a highway than a well lined up and well constructed guard fence, painted white as it should be. Outside of the safety features of a guard fence, they add a feature of beauty to the completed road structure, if properly built.

Trees and Shrubbery.

Every tree which adds any beauty to the landscape should be saved, if possible, and where there are groups of trees offering effective relief it is worth while to make such changes in the centre line as will save these trees, even if additional right of way on the other side has to be secured. A good tree takes many years to grow and can be cut down in a few minutes. Most of us have been wasteful in our destruction of good trees and have not made the exceptions which should have been made in saving trees or groups of trees of distinctive character and merit.

As to brush and shrubbery. Within the limits of slopes, brush and shrubbery, as well as all other vegetation, have to go. In many cases, however, the clearing and grubbing limits are defined as wider than the slope limits, and thousands of acres of effective shrubbery and flowers have been destroyed which could just as well have been saved. In other words, the clearing and grubbing limits should follow the slope line. In the northern States, where snow drifting can be expected in many places along the roadway, low growing brush cannot be encouraged as it promotes snow drifting unless the line of brush is well back from the edge of cuts.

Incidentally we probably have not paid enough attention to buying additional right of way where snow drifts occur and planting shrubbery far enough back in the fields so that the snow will not be thrown into the road cuts. It is our opinion that this is the most effective form of keeping the roads open and should be used much more widely. The debate between shrubbery and snow fences as means of locating snow drifts, is probably close, but we shall not enter into it here.

If anything really effective is to be done it is the writer's opinion that it must be done by the state highway departments in cooperation with the state forestry departments, and not only must the trees be planted but they must be carefully attended to until they are old enough to take care of themselves. We will undoubtedly see advances in this direction within the next few years. With good care and judgment exercised in the selection and planting of trees of suitable character there is nothing objectionable about planting trees along highways and much to be said in favor of it. Even if in some cases a bonus has to be paid to abutting farmers on account of losses due to shading, it is well worth while from the public standpoint, and we believe it is possible to secure such relinquishments from abutting farmers where tree planting

is advisable at a very reasonable cost, considering the artistic effects and real benefits to be secured. Even in well timbered States there are sections where a little green on the landscape and a little shade is very welcome indeed. The general remarks as to trees apply also to shrubbery. Planted with discretion, shrubbery and flowers certainly add very much to the general roadside effect.

Grade Crossings.

In planning new main highways every possible effort should be made to secure the elimination of grade crossings. Much can usually be done in relocating the highways so as to avoid crossing the railways at all. Where two crossings with the same railway line lie within five miles of each other, it will usually be cheaper to buy a new right of way on one side of the track and to grade, drain, culvert and bridge the new right of way, than it will to separate the two crossings. If, however, there is something which must be met on the opposite side of the track, that is, a village or city, which it is necessary to accommodate, this course is not always feasible, although quite usually between the two crossings some point can be found where a separation can be made accommodating traffic to and from the city or village in question, while the main line of traffic is left free.

Each case has to be decided upon its merits but both undergrade and overgrade crossings have disadvantages in alignment, and the best solution in four cases out of five, where the crossings are not too far apart, is to relocate along side the track. Where a highway has to cross a railway an overhead is quite usually superior to an undergrade crossing for several reasons, and is usually less expensive.

Up to very recent years, about two out of three grade separations built by the railroads have, in reality, been more dangerous to highway traffic than are grade crossings, because the railroads paid no attention to the matter of highway alignment and used in almost every case crossings perpendicular to their tracks with two sharp and sometimes blind approach curves. Such crossings are seldom, if ever, satisfactory where the highway is in general paralleling the railroad as many main highways naturally do, and when skew crossings have to be built the decision almost inevitably falls upon relocating the highway.

Highway intersections, especially high speed intersections, are another source of grave danger. All intersections should be well signed on both highways and in addition good Y's should be put in in each direction, because such Y's serve to increase the vision for the traffic which crosses perpendicularly, and the traffic which makes the turns fits into line much better if its course is changed as it comes into its new line of travel.

At many crossings of two supremely important highways it is undoubtedly going to be necessary to separate these highway crossings just as railroads have found it necessary to separate their important crossings. This may sound extreme, but where such cases exist on really important lines of traffic, there can be no doubt that the separation of the two roadways is not only desirable but an economic necessity.

Roads Under Construction.

If a road is to be kept open to travel during construction, the safety and convenience of the traveling public should be the paramount consideration rather than almost totally disregarded and the traveller considered as an interloper, as is the case in too many instances at the present time. Roads under construction should either be wholly closed to general traffic, or kept open under conditions which guarantee safe and easy passage.

If kept open, grading should be kept closely in hand. On ordinary roadwork there is no great reason why there should be more than one mile between the completed grading and the first plowing ahead. Contractors would be, in most cases, much ahead if instead of spreading their work over the whole length of the contract and finishing

nothing until the last operation, they would keep the grading operation well in hand and finish as they go, starting a slope trimming and finishing crew as soon as the roughing out has proceeded not over a mile.

Too heavy lifts are used on many highway jobs. That is, three or four feet off the end of the fill. This is contrary to most specifications, makes a poor road, badly compacted, and besides gravely inconveniences the travel both in going up and down the breast. Even where the cut is not completed or where the fill is not completed, it can be kept reasonably smooth by operating a grader constantly over it as the material is being cut and filled.

The most striking difficulty on roads kept open during construction is the short detours around culverts and bridges. In the case of bridges, wherever the alignment permits, it is much better to build the bridge on a new site even at a cost of a few hundred dollars additional, and permit the traffic to use the old bridge rather than a temporary structure. In quite a reasonable number of cases curves happen near bridges, and it is possible by a new alignment at the point to build a new bridge and maintain the old one during construction.

In the case of culverts, instead of detouring the traffic across the ditches and through fields, usually in impassable condition after each rain, we should build the culverts in two sections. While slightly more costly to do this, the additional cost is made up many times in savings to traffic. We have experimented with this during the last season and our plans and specifications for next year are going to call for the construction of culverts in two sections wherever we expect to keep the road open for traffic.

Detours.

In some of the eastern States roads have been built in halves and the traffic dispatched in a single direction by a system of telephoning. We, this year, travelled over sections of highway so handled, and it was our impression that for a main line of traffic this method was totally unsatisfactory and that if the money expended in dispatching and in additional cost of construction under such conditions had been spent in temporarily fitting a detour or detours for traffic, the result could not help but be more satisfactory, unless there was positively no available detour.

Where highways under construction are to be absolutely closed and traffic detoured, considerable attention should be given to these detours, and the road over which the detour is to be carried should, if possible, be given the proper amount of attention the preceding year. Where opportunity exists it is much better to put in a detour for one line of traffic, and to use another highway for traffic going in the opposite direction. If the roads on which the detours are placed are necessarily narrow, this avoids many complications in meeting, and many accidents, and facilitates the passage of both lines of traffic. Further the detour roads are not quite so seriously damaged if the traffic is halved. We feel that where there is any question of reasonable doubt the double detour should be used.

A good many present day highways must be detoured when constructed. It is practically impossible to construct a concrete road without detours. The same is true of almost every road except gravelling and grading jobs. But the cost of detouring is a very heavy charge upon the travelling public. Almost invariably the detours are longer than the road under construction, and if the road under construction is a heavily travelled one, the cost to the traffic of making a detour, even one mile longer than the straight road, is very heavy. For instance, a detour three miles longer than the main road, carrying a traffic of 800 vehicles a day, means a daily total of extra travel of 2,400 miles, which even at 10c a mile is \$240 per day. If the road under construction is kept closed for four months, the cost of detouring would be \$28,800, and unless the structure is of such a character as to absolutely preclude taking traffic through, any reasonable expenditure in keeping it open for traffic can be seen to be fully justified.

Something can be done for both safety and beauty by proper maintenance. Brush interfering with vision at corners should be kept well cut, and the roadside should be kept mowed. All signs directing traffic, both on main roads and detours, should be well maintained. Engineers usually go through the work itself and very seldom use the detours, and we have discovered cases where practically all signs were down on detours without the men directly in charge knowing it, because they never used the detour but went through the work.

Detours should be in charge of the maintenance department and not the construction department, and the maintenance engineers should travel the detours whenever such exist.

Build safety into the structure by proper design rather than expect to provide safety by large expenditures of paint and signs after blunders are made. Without proper design, maintenance can do little toward providing safety except in cases of disaster to the road structure. Maintenance can, however, add to the beauty factor by providing well kept surfaces, shoulders, and ditches, and by keeping all signs and attendant structures well painted or clean. Maintenance can add to safety also by properly cutting shrubbery and trees which interfere with vision.

Conclusions.

Both from the standpoint of safety and beauty, the future fate of any section of highway is practically decided by the original layout and by the design of the highway and its structures. Some beauty can be preserved by care in not ruthlessly destroying during construction, but much more can be saved of the thought of preserving worth while beauties is in the mind of the designing engineer. Surveyors should accurately locate trees and other features of especial aesthetic value and should, if possible, determine methods of saving these features while in the field making the original surveys.

It is almost impossible to spend too much money in promoting safety on our main highways. It is probably likewise almost impossible to spend too much money in the promotion of beauty, because no state will get very far with the promotion of beauty before it will be stopped by the protests of its taxpayers. The taxpayers will stand for a large dose of expenditures for the promotion of safety, but they are not yet ready to spend very large amounts in the promotion of beauty. This last is a matter of education, while much of the education along safety lines has already been acquired. It is the author's opinion that we cannot possibly be too extreme in the design of highways in regard to all factors which make for public safety.

With the exception of so few that they are scarcely worth mentioning, I do not know of one American highway, built ten years ago which is today adequate for the traffic upon it. Either it fails as to width, or it fails as to adequacy of surface, or it fails as to safety features, to measure up to today's standards.

A state highway department which is not being severely criticised because of its drastic relocations, because of its drastic treatment of curves, because of its drastic treatment of widths, is not measuring up to its responsibilities of leadership in American highway development. We should all go as far as we dare go, and then venture a little further, because only so will we even approach the standards of tomorrow. May we all have the vision and the courage to plan and build aright!

SOME ECONOMIC ASPECTS OF HYDRO-ELECTRIC POWER DEVELOPMENT.

At the final session of the symposium on water power development held recently at the University of Toronto, Norman R. Gibson, hydraulic engineer of the Niagara Falls Power Co., Niagara Falls, N.Y., lectured on the economic aspect of hydro developments. He pointed out how the growth of power plants has followed the old economic

law, the cheapest product in the dearest market; in other words, power plants are first developed where the cost of development is lowest and where the disposal of power is easiest due to either lack of competition or high cost of other power.

In this manner the production of hydraulic power in Canada, where there is little coal, represents about 93% of the total central station output, while in the United States, where coal is abundant and moderately cheap, hydraulic power represents only 37% of the total central station development.

Mr. Gibson pointed out that the low cost of power is not a necessary requirement for the domestic market, such as large cities, where the bulk of the use is the individual consumer, but that low cost is vital for large industries whose output depends entirely on cheap power; the production of aluminum, chlorine and caustic being instances of the latter.

The effect of the diversity factor on the sale of power was pointed out and it was found that due to overlapping of the requirements of various consumers, the power plant owner can frequently sell from two or three times the horsepower capacity of his plant. This sometimes led to an apparent discrimination in rates, and was frequently advanced as an argument for the selling of power on an energy rather than on a capacity basis.

The items that must necessarily enter into the rate for sale of power are:

1. Operating expenses, comprising labor and supplies and small maintenance repairs.
2. General overhead, comprising expenses of manager, superintendents, and general overhead.
3. Municipal and Government taxes.
4. Depreciation and obsolescence.
5. Interest on invested capital, or profit.

Particular stress was laid on the fourth feature, namely, the setting aside of a certain income each year to return to the investor when the plant is worn out or has become obsolete. The determination of the rate to cover this feature is a subject of much investigation, and by its very nature can never be accurately determined.

Mr. Gibson closed his address by pointing out the practical impossibility of making close estimates, either for capital cost or for annual charges of projects which go beyond the limits of previous experience, as conditions always arise which nobody could possibly foresee.

Mr. Gibson showed several slides of the various developments of the Niagara Falls Power Co., indicating the progressive development in the art to meet the advancing economic requirements.

CALGARY CONFERENCE ON ALKALI PROBLEM

REPRESENTATIVE engineers and chemists of Western Canada are meeting in Calgary this week to discuss the very important question of the effect of alkali on concrete. The Concrete Committee of the Engineering Institute of Canada has been summoned to confer with Duff A. Abrams, professor at the Structural Materials Research Laboratory of the Lewis Institute, Chicago.

In addition to his conference with the Concrete Committee, Prof. Abrams will address the Engineering Institute in Calgary on "Scientific Methods of Mixing Concrete."

Following are some of the members of the committee who are conferring with Prof. Abrams: Prof. C. J. McKenzie, dean of engineering, University of Saskatchewan, who is the chairman of the Concrete Committee; Prof. Findlayson, dean of engineering, University of Manitoba; A. S. Dawson, chief engineer, C. P. R. Department of Natural Resources; Prof. R. L. S. Wilson, University of Alberta; A. H. Haddow, city engineer, Edmonton; Prof. J. A. Williams, University of Saskatchewan; Dr. Thorwaldson, University of Saskatchewan; Dr. Shipley, University of Manitoba; W. P. Brereton, city engineer, Winnipeg; Dr. J. A. Kelso, University of Alberta; F. C. Field, city chemist, Calgary; and George W. Craig, city engineer, Calgary.

PROBLEMS IN SEWER DESIGN AND MAINTENANCE*

Poor Design Will Result in High Maintenance Costs — Efficient Sewerage and Drainage System at Baltimore — House Connections

By Milton J. Ruark,

Division Engineer of Sewers, Baltimore, Md.

DESIGN and the maintenance of a sewerage or drainage system are two distinct and independent functions. Usually the engineer responsible for the designing is especially trained in this particular branch of engineering; is qualified to make the necessary surveys and calculations, and can execute detailed plans and specifications to the satisfaction of the State Board of Health or other authorities. Unfortunately, however, the consulting or designing engineer seldom has the opportunity to operate and maintain the systems, which he has planned. His knowledge of maintenance problems is, therefore, mostly obtained from others, and is not his own experience. It is, therefore, to be expected that he will not be able to anticipate all of the maintenance difficulties, some of which may be due to local conditions, and the burden of successfully operating the system must be solved by someone else who may or may not be particularly qualified or have knowledge of the principles involved in the original design. If the engineer has exercised ordinary skill, and given sufficient thought and study to the subject so that the proper and most suitable system is adopted; if designs are prepared and detailed in an accurate manner; and, furthermore, if the plans and the specifications have been followed out by the engineer in charge of the construction, it is safe to say that maintenance problems should be few, and of such a character that only minor modifications to the system will be required, and the operation cost will therefore be small.

On the other hand, maintenance problems are often numerous, difficult to correct, and involve unreasonable up-keep charges because the sewerage system has been either poorly designed, or as is more commonly the case, constructed in haphazard manner without sufficient engineering supervision. Where the designing engineer of the system is one who is familiar with the maintenance problems, he will, of course, avoid many errors and pitfalls that he has become aware of through experience.

Baltimore Drainage System.

The Sewerage and Drainage System of Baltimore, approximately 90 per cent of which was built between the years of 1906 and 1916, has now been in service about 10 years. At the time when preliminary plans were submitted and approved, there was much difference of opinion as to the best methods of design to follow. In a great majority of instances it is clear and beyond dispute that the designs of the engineers, adopted and carried out in detail, were the best ones although there are a few cases where equal or better results might have been obtained by using some other and perhaps less expensive method.

One of the chief results to be obtained by the sanitary engineer is a sewerage system that will be free of obstructions, chokages and foul odors, and which can be kept in this condition by ordinary maintenance labor. The prevailing impression is that if the grades of the sewers are sufficiently steep no trouble will be experienced with deposits forming in the sewer. The problem, however, does not end with the designer. He may have provided for sufficiently high velocities, and nevertheless when the sewer is put in service obstructions will frequently occur especially if good construction work is not insisted upon.

Trouble Through Tree Roots.

More important than good grades is a selection of good quality pipes, and skillful pipe laying. Pipe must be

smooth, straight, and in continuous alignment throughout without the irregularities and kinks which so often occur due to the interference of other underground structures. Each joint must be made as tight as practicable, and the well established principle of straight horizontal and vertical alignment between properly spaced manholes must be observed. One of the chief causes contributory to obstructed sewers is tree roots. Where skillful pipe layers are employed, and good tight joints are made, the probability of an obstructed sewer from this cause is reduced to a minimum. Roots from the common poplar tree are responsible for most of the trouble in Baltimore, and occur more frequently in the house connection than in the lateral sewer. This trouble, however, has not been experienced in storm water drains, and is probably accounted for by the fact that small drains carry little or no flow during dry weather. Even where bituminous compound joints have been used as a precaution against tree roots, they have found their way into the sanitary sewers. It is a recognized fact that poplar trees have little value as shade trees, and that the roots also cause failures of cement or brick sidewalks. For this reason an ordinance has been passed in this city prohibiting the further planting of this species of tree. The demand and market for many of the complicated mechanical sewer cleaning apparatus so widely advertised by manufacturers is due to the fact that many municipal sewerage systems in this country have been poorly designed and constructed.

Plumbing Regulations.

When the sanitary sewerage system of Baltimore was put in service, each building, premises and establishment was required to be connected to the sewerage system at the expiration of 60 days after being notified by the Health Commissioner. The regulations required that the existing plumbing be made to conform with a revised plumbing code under which all wastes of a polluted character were required to be disposed of into the sanitary system, and rainwater or other non-polluted waste into the storm water system. Rain leaders, which were permitted to be discharged upon the surface, were connected to the storm water system at the option of the property owners. These regulations were enforced in all instances ever where a building was connected to a private sewer, and considerable money had to be spent in rearranging existing plumbing to conform to the new regulations. In cases where property owners failed to comply with this notice within a reasonable time, the health authorities had the power to make these connections to the city system, and the cost of the work became a lien upon the property. Where the property owner was not able financially to do this work, the city also arranged to have the work done by the owner's plumber, the owner paying the cost, with interest, in five annual installments. The rigid enforcement of the above regulation; the elimination of all cesspools and old outside running traps, which are still in use in many cities, has done much to improve sanitation in Baltimore.

Notwithstanding that the reconstruction of the house plumbing and the cost of making sewer connection has involved an expenditure, according to the least conservative estimate, of \$8,000,000 on the part of the property owners, it has been demonstrated that the benefit derived has justified the course taken by municipal officials. In the business districts the majority of down-spouts are connected direct to the storm water drainage systems. The practice of making separate connections to the storm water system has increased, and it is a question whether it is not better to provide a separate connection in order to dispose of all water from roofs, area-ways, subsoil drainage, and water from garage floors. If this practice were followed, large quantities of rain water would be eliminated from the surface of streets; but some authorities claim that it is better to discharge water on the surface, as it tends to keep the streets in a cleaner and more sanitary condition.

With the exception of a few low-lying drainage areas there are no catch basins in Baltimore, and it is not likely

*Paper read before the American Society for Municipal Improvements.

any will be built in the future. Most of the storm water drains are self cleaning; and the building of catch basins would therefore serve no useful purpose, but would probably become a nuisance. Catch basins are very expensive to clean out. They soon fill up with silt, and it is difficult if not impossible to prevent street sweepers from disposing of street sweepings in these inlets in order to lessen their labor. Furthermore catch basins often retain a good deal of decomposed matter, and they cause complaints because of odors, and prevent a free circulation of air through the drainage systems.

Marking Manhole Covers.

Although the design in manhole covers would seemingly play an unimportant role in sewer design, there is room for much improvement along this line. Where the separate system is used, covers for sanitary sewer and storm water drain manholes should be clearly marked with such words as "Sanitary Sewer" and "Storm Drain" so that all municipal employees can tell the kind of sewer without taking the cover off. A penalty should be imposed for removing these covers, and the amount of the fine should be marked on the sewer. Where the separate system of sewers is used, the manhole frames and covers should not be of the same size for both systems. Unless the covers are of slightly different diameters they will be interchanged and cause much confusion in maintenance work. For example, snow is likely to be dumped into sanitary manholes under the impression that it is being disposed of into the storm water drains, which practice causes much trouble.

During the early days of the Baltimore Sewerage Commission six holes, each 1 in. in diameter were provided for in the top of manhole covers for ventilation and for removing them. As the sewers get ample ventilation through the house stacks this number was reduced to two without any ill effects. Were it not for the fact that some means have been provided to take the covers off, no holes would be put in them at all. A good deal of ground water would thus be eliminated from the sewerage system which is treated at the sewerage works.

Complaints have been made because of loose manhole covers which rattle when traffic passes over them. Experience at Baltimore has shown that the best way to remedy this condition is to have all manhole frames and covers inspected at the foundry. Only those castings that fit well are selected. They are bought by the city, and furnished to the contractors who are building sewers.

Although lampholes were built on the sanitary sewers of Baltimore when the system was first installed, this practice has since been discontinued. They are a source of trouble as mischievous children remove the lamphole covers with little difficulty, and drop sticks and rubbish in the sewers, which become choked. If sewers become obstructed, lampholes are of little or no value in clearing them, and it is seldom that they facilitate maintenance work in any manner whatsoever. Furthermore, even when carefully constructed the lamphole will frequently settle and break away from the lateral sewer due to unequal settlement. House connections, which are made from deep sewers by means of standpipes, are also a source of many troubles due mostly to settlement.

Garage Connections.

It is unlawful in Baltimore to connect garage floor drainage to the sanitary sewers. Thus, one of the main causes for gas explosions in sanitary sewers is prevented, although explosions have caused serious accidents in many cities. There is no record of explosions in any of the Baltimore sewers. It is permissible to connect garage drainage to the storm water drains, but the plumbing regulations require that an approved trap of ample capacity be installed on the house side of the sewer connections so as to intercept any gasoline or oils that might otherwise flow into the storm water drain.

One and one-quarter inch taps from the water mains of the city were originally extended to each terminal or

dead-end manhole as the occasion required. The practice of installing these taps has also been discontinued as it has been demonstrated that only occasional flushing is necessary, and that the connections often rust out and become leaky in a short period of time. For similar reasons the use of flush tanks has been limited to serve sewers which are laid on very flat grades, and their use ever under these circumstances is questionable. Moreover, there have not been many complaints of deposits in sanitary sewers that are at or near the end of the lines.

In Baltimore four men spend all their time in making periodic inspections of all manholes. They remove from the manhole benches such things as sticks, rags, bottles and other material that might choke the sewer. Often they find that some sewers are partially obstructed, and they immediately have these obstructions removed. This work reduces the amount of money expended in clearing the sewers, and at the same time there are fewer complaints from property owners because of flooded cellars.

Sewage Pumping Stations.

A gravity system of sewers should be installed whenever it is possible so as to reduce pumping to a minimum. The design of a pumping station, either large or small, requires very careful consideration and a vast amount of detail work. Extreme caution must be exercised that the proper type of mechanical and electrical equipment is selected. Ample space for units to meet future requirements must be provided, and reserve units must be installed in case of a breakdown. The average daily flow at the main pumping station in Baltimore is 25,000,000 gals. and the maximum flow has at times reached 38,000,000 gals. per day. Nevertheless, this station has been in continuous service without interruption, and the successful operation of a station of this size is assured if the equipment is first class, kept in good repair, and a competent, reliable staff of power plant operators is provided. That pumping stations of both large and small capacities can be located in congested districts without becoming objectionable to adjacent property owners, and further that sewage screenings can be disposed of by incineration within the pumping station without causing a nuisance has been clearly demonstrated by the operation of such a station in Baltimore.

Sewage Treatment.

One feature of sewage treatment that has demonstrated itself is that it is practically impossible to eliminate complaints because of odors from a large plant. A sewage treatment plant of any size is bound to give off odors and the engineer who claims that he can eliminate them altogether will be disappointed when he faces actual operation conditions. Theoretically a certain method of sewage treatment may be used without producing odors, but when all weather conditions are encountered, when wide variations in sewage flow occur, and when the plant is operated by poorly trained men who are negligent, aerial nuisances almost invariably arise. Very often complaints from odors are unfounded or are exaggerated. Human psychology is such that people, who live in the vicinity of a sewage treatment plant, often imagine that they get odors from the plant when such is not the case. Where the land can be bought at a low price, it is advisable to buy a large tract as was done at Baltimore in order to isolate the plant, and reduce the number of lawsuits which are bound to follow. After the plant is built, any land bought in the vicinity of the plant can be resold with the provision that the purchasers will not enter suit against the municipality.

Improvements In Design.

Within the past 10 or 15 years great advances have been made in sewer design. The rational method of designing storm water drains has been introduced. The separate system is becoming more firmly established. A great deal of information has been compiled as to the hydraulics of sewers, and many other valuable data have been obtained. But much remains to be done. Engineers should ascertain with a greater degree of accuracy the value and

advisability of using concrete for sewers as compared to terra cotta vitrified earthenware pipe, the effect of various kinds of sewage and industrial waste flowing under different velocities and conditions both in concrete and brick lined sewers, and the life of these materials under such conditions. Engineers should as a matter of public service make a more detailed study of the storm water run-off from various kinds of pavements, etc., the percentages of water entering different types of inlets under varying surface grades and conditions. It is true that engineers have not learned the last word pertaining to the design and construction of sewers, but much ground has been covered. The most fertile field for investigation and research in sanitary sciences lies in the field of sewage treatment, and it is not unlikely that within a few decades our present methods of sewage treatment will give place to other methods, which are more economical and efficient.

POWER HOUSE MACHINERY

AT the recent symposium on water power development held at the University of Toronto, the fifth lecture was by W. M. White, chief hydraulic engineer of the Allis-Chalmers Co., Milwaukee, who spoke on "Power House Machinery." This lecture was well attended and proved very instructive to the audience. Mr. White prefaced his talk with an illustration of the manner in which modern progress is in direct proportion to the use of power, showing how developments in any district are followed by rapid industrial and social growth. The Niagara district, the Montreal district, the Southern California district, Japan and Formosa all furnish typical instances of such growth. The Japanese Government has proved this fact to their own satisfaction to such an extent that they are proceeding with a 150,000 h.p. development in Formosa, even though the present demand there is not in excess of 10,000 h.p.

Slides were used by Mr. White showing the various construction details of turbines, illustrating the finer considerations of design. The use of varying angles of the speed ring vanes to compensate for the relative increase in velocity on the inside curve of the scroll case was illustrated. Details of construction and illustrations of the plate steel scroll case were presented in a very interesting manner. The methods of designing the runners to maintain full buckets with the water in complete contact with the vanes at all times was pointed out, and the effect on the runner by pitting was graphically shown.

Mr. White pointed out that there were two functions required of the draft tube, one to form a seal between the runner and the tail water, and the other to return to the runner the energy contained in the water when it entered the draft tube. The development of the hydracone from experiments in 1904 of a jet impinging on a flat plate through various forms of discharge surfaces was discussed, and numerous illustrations of the hydracone installations were shown.

The development of the high specific speed type runner was then taken up and an interesting slide shown illustrating a propeller-type runner now being built in the shops of the Allis-Chalmers Co. for the Ford plant near Albany, N.Y. This runner is 13½ ft. in diameter, and will deliver 2,000 h.p. under 17 ft. head. The specific speed is approximately 150 (in English units), and it is in appearance much like a ship propeller with four flattened blades.

After showing further slides indicating especially interesting features in various plants, such as the direct-connected fly-ball governor developed by Mr. White, and a head increaser by the utilization of the flow over a dam to act as a "puller" on the tail race under the dam. Mr. White closed his address by pointing out the virtue of developing concentration and a "sixth sense" in all hydraulic work, with particular reference to testing.

Wellington County last year spent \$270,604.86 in the construction of county roads and in Puslinch township \$131,319.74 was spent on good roads.

BIG ROADS PROGRAM FOR QUEBEC.

ABOUT \$7,500,000 will be spent on Quebec highways this year according to the good roads program recently announced by Hon. J. L. Perron, Minister of Roads in the Quebec Cabinet. The money will be apportioned as follows: Regional roads, \$3,450,000; Municipal work (by day and contract) \$2,100,000; Rebuilding and upkeep \$1,450,000; Special works and administration, \$500,000.

The road work will be performed in three divisions which for the purpose of this work have been made in the map of the Province.

District No. 1 includes the following counties, Gaspé, Bonaventure, Matane, Rimouski, Temiscouata, Kamouraska, L'Islet, Charlevoix, Montmagny, Bellechasse, Lévis, Lotbinière, Dorchester, Beauce, Mégantic, Wolfe, Frontenac, Lake St. John, and Chicoutimi.

District No. 2 includes the following counties, Compton, Sherbrooke, Stanstead, Richmond, Chateaugay, Beauharnois, Arthabaska, Nicolet, Drummond, Yamaska, Huntingdon, Brome, Shefford, Missisquoi, St. Hyacinthe, Bagot, Rouville, Naperville, Richelieu, Iberville and St. John.

District No. 3 includes the following counties, Quebec, Montreal, Portneuf, Champlain, St. Maurice, Maskinonge, Berthier, L'Assomption, Joliette, Montcalm, Chambly, Vercheres, Laval, Jacques Cartier, Two Mountains, Terrebonne, Argenteuil, Vaudreuil, Soulanges, Labelle, Hull, Pontiac and Temiscamingue.

Work has commenced in some sections, some more contracts will be awarded this week, and by June 15 the entire province will be engaged in road-making and this will keep up until September 15 when the entire programme will be completed.

Leading District No. 1.

Important work is planned for this district in the coming season. This district comprises the entire lower part of the province, Lake St. John, Beauce, and a section of the Eastern Townships. In this district are located the Lévis-Rimouski route, the Rivière du Loup-Edmundston and the St. Alexis-Jonquière, and also the first section of the Lévis-St. Lambert route up to the limits of the counties of Nicolet, and about half of the Victoriaville-Woburn route. There are still several important contracts to complete in this district, and a great deal of the work will be done by day in the various counties in this part of the province.

As far as the Lévis-Rimouski route is concerned, there is a good part of this road already improved, and this year there remains the task of making the worst sections passable, so that the road is free for traffic from one end to the other. Important work on the Lévis-Montmagny section of this road, and also for other sections in the counties of L'Islet, Kamouraska, Temiscouata and Rimouski.

The Rivière du Loup-Edmundston road will be finished this year. The Roads Department recently let a contract for the construction of that part of it known as Ste-Rose du Degele, near the borders of New Brunswick and work has already begun at that section.

Important work will also be done this year on the St. Alexis-Jonquière road, notably in the municipalities of St. Ambroise and Chicoutimi Canton. This road will provide the first trunk of the Chicoutimi-Roberval road and will serve the entire Lake St. John district.

In district No. 1 there will also be the construction of the Lévis-Lotbinière section of Lévis-St. Lambert road on the south shore. Part of the Victoriaville-Woburn road is also under the control of the organization in district No. 1, in the counties of Frontenac and of Wolfe. Work continues throughout the year.

The Woburn and Whittton sections are notably features of this year's work. This road crosses the Eastern Townships diagonally, and is also known as the Portland-Three Rivers road.

An amount of \$200,000 has been set apart on the 1922-23 budget in district No. 1 for rebuilding and up-keep work. This rebuilding work consists principally of the macadam

built eight or ten years ago, in the early days of the good roads act. In most of these instances, the work will be a resurfacing of the worn out top and covering with oil. The Department of Roads is now asking for bids for this work.

Bids will be asked very soon for the construction of these 22 miles located between the city of Quebec and Ste. Anne de Beaupre.

District No. 2.

Provincial and regional roads.

The projected work on the regional and provincial roads for this section in this district will be the following:

Montreal-Sherbrooke road—Bids to be asked 16.58, length under contract 23.66 miles, bid asked 27.58 miles.

The part where bids have not yet been asked comprise the canton of Granby, the parishes of St. Paul d'Abbotsford and Rougemont, as well as the village of Rougemont. Preliminary survey work will be commenced in a few days and bids will be asked for in a month.

The construction of the Levis-St. Lambert road from Corel to Montreal is on this season's program. The part located in district No. 2 extends from Sorel to Contrecoeur, and is 9.92 miles long.

Work on the Richmond-Yamaska road commenced about the end of 1921 season. The season of 1922 will see the construction of 8.17 miles, comprising the section between Richmond and Drummondville.

Levis-Sherbrooke road—Length built 51.80, total length in No. 2 district 74.29 miles, length to be built in 1922 18.49. The stretch of 18.49 for the season of 1922 will complete this road in district No. 2 except for four miles in Shipton canton, Richmond county. The building of these four miles will be begun as soon as possible.

Laprairie-Lacolle road (via St. John)—Length built 2.47, to build under contract 1.75, for 1922 1.75 miles.

Work By the Day.

A substantial sum has been set aside for municipal work in the different counties of district No. 2. Works of considerable magnitude are down on the programme for 1922 in nearly every municipality of the Eastern Townships and in the Richelieu district, as well as the counties of Laprairie, Napierville, Chateaugay and Huntingdon forming part of this district.

Gravel seems to be particularly favored in this region, but macadamizing is being done in several municipalities. Improvement of roads has been carried on to a considerable extent in every section of the province comprised in this district No. 2, and certain municipalities have improved every one of their roads.

Rebuilding.

Rebuilding will be carried out during the season in No. 2 district as follows:

1—On the Caughnawaga-Malone road, in the municipalities of Ste. Martine, Tres St. Sacrement, Howick, St. Malachie d'Ormstown, village of Ormstown, Godmanchester, and the town of Huntingdon, all of which is to be done within the counties of Chateaugay and Huntingdon. The total length of the rebuilding to be done is 23.43 miles.

2—On the Laprairie-Valleyfield road, in the municipalities of St. Joachim of Chateaugay and the village of Lery, over a distance of 5.02 miles.

Laprairie-Valleyfield road—Length under contract 4.5 miles, bids to be asked 2.5 miles.

3—On the road between Valleyfield and Ormstown, in the municipalities of St. Malachie d'Ormstown, St. Louis de Gonzague and Ste. Cecile de Beauharnois, over a distance of 3.55 miles.

4—On the Sherbrooke-Norton Mills road, in Compton canton, for 7.47 miles. This section of the road is situated between the town of Sherbrooke and the town of Coaticook.

5—On the Montreal-Sherbrooke road, in the village of Richelieu, for a distance of 0.92 miles.

Besides this rebuilding of the main roads there are also other important rebuilding projects, bids for which will be opened shortly. These are as follows: In the Dun-

deed canton 9.12 miles, in St. Constant parish 4.61 miles. The estimated cost of all this rebuilding work in district No. 2 is set down as \$430,000 for this year.

Upkeep.

There is upkeep work projected for district No. 2 in 240 municipalities on a length of 1,000 miles.

District No. 3.

Montreal-Mont Laurier road—Total length 152 miles, length under contract 37.44, bids (rebuilding) asked five miles, length to complete 15.71 miles, bids to be asked 93.85 miles.

The 37.44 miles under contract will be terminated this season, as well as the five miles of rebuilding.

Montreal-Hull road—Total length 112 miles, length built 23 miles, length under contract one mile, bids to be asked 69 miles, bids to be asked (rebuilding) 19 miles.

All the rebuilding necessary and the construction of that part of the road between Montreal and Lachute will be completed this year.

Levis-St. Lambert road—Section Montreal to Sorel—Total length 37 miles, bids asked for construction 18.5, bids to be asked (rebuilding) 7.5 miles, length completed 11 miles.

Quebec-St. Simeon road (Quebec to Ste. Anne de Beaupre)—Length from Quebec to Ste. Anne 22 miles—Bids will be asked very soon for the construction of these 22 miles located between the city of Quebec and Ste. Anne de Beaupre.

Montreal-Toronto road (length 46 miles)—Along this entire road there are only the parts situated in the parish of St. Zotique, village of St. Zotique and the parish of Ste. Claire-d'Assise, 7.24 miles which have to be completed. The rest figures in the rebuilding program. This 7.42 miles will be built this year.

BEARDMORE-TOSI ENGINE TEST.

SUCCESSFUL tests have been made with a Tosi type internal combustion engine built by William Beardmore & Co., Glasgow. The engine, which is one of the several which are being built in the Beardmore shops for cargo vessels now under construction, is of the four-stroke cycle single-acting six-cylinder type, designed to develop over 1200 b.h.p., and on a 100 hours' trial gave an average brake horse-power of 1267 on a fuel consumption of .42 lb. per brake horse-power per hour. In reversing tests, the time of the change over from full ahead to full astern was 8 sec. This unit is to be installed in a single-screw vessel of 2000 tons, the Pizarro, which will be launched during the present month.

WORK ON YORK COUNTY ROADS.

CONSTRUCTION is well under way in York County on the good roads system. Large quantities of building materials are available and in twenty different sections of the system, existing earth roads are being prepared for a suitable base and permanent surfaces are being laid. The work is being carried on with the minimum of interference with traffic movement and where detours in the system are necessary they have been carefully laid out.

The work is spread out over the whole system. Sections of men have taken over 1 1/4 mile blocks at different points and have the preparatory work well under way. The greatest activity at present centres round Todmorden, Highfield, Weston, Agincourt, Unionville, Sutton, King and Downsview though a considerable amount of work is being undertaken in other sections.

The beginning of the 1922 program brings to light the fact that, in common with almost everything else, road building costs have decreased. Taking all factors, it is estimated that the cost of constructing a given length of road is from 10 to 12 per cent. less than it was in 1921.

PLANT INSPECTION TO INSURE GOOD BITUMINOUS PAVEMENTS*

Three Cases Cited Where Lack of Inspection Resulted in Failure of Road — Details of Each Case and Cause of Failure.

By Francis P. Smith,

Consulting Paving Engineer, New York City.

ANYONE who has thought of the subject of this paper and is familiar with the various processes of construction regards it as an axiom that plant inspection is a necessity. It is a fact, however, that in all highway organizations there are a number of officials and engineers who have not made a special study of bituminous construction. Let us assume, for the minute, that we are in the position of an engineer who has not specialized in bituminous construction. Certain contracts have been let in his district for asphalt pavements. His appropriation is more or less limited and perhaps he is doubtful as to the real necessity for plant inspection. After the foundation has been laid and is ready for the bituminous top, he visits the plant. He finds it in operation apparently running all right, the batches being turned out and the sand assembled and fed to the dryers and the trucks are leaving with fair regularity and the mixture looks all right. It is black and the sand seems to be fairly well coated. He takes a sample from the load and tests the temperature and finds it comes within the limits of the specification requirements. From there he goes to the road where he finds the trucks delivering the hot asphaltic mixture. It is being shovelled, spread and rolled in good workmanlike manner and he comes back to his office and thinks: "What real necessity is there for an inspector at the plant? Everything seems to be going all right, and why visit the plant more than once a day and the street occasionally? Why is not that sufficient?" and so he lets it go at that, and if he is fortunate enough to get a good pavement he is liable to come to the conclusion that plant inspection is not a necessity but a more or less expensive luxury which can be omitted when appropriations are scanty. There is another side to the question, however, and as I firmly believe that it is true that we learn more from our own failures and mistakes than from any other source, I am going to cite certain failures which were wholly due to inadequate inspection as possibly the best way of emphasizing the point which I am here to make.

Three Cases Cited.

Fortunately for my illustration, within the last three years, three failures of bituminous pavement have come to my attention. In all of these cases it happened that I was entirely familiar with the circumstances attending their construction, the kind of materials used, the personnel of the contractor and the engineers under whose direction these pavements were laid.

In the first case, the engineer decided to limit his inspection to daily visits to the plant and street supplemented by a daily analysis of a sample taken when he visited the street. Instead of a complete analysis he determined the bitumen content only, on the theory that the amount of asphalt that went into a bituminous road was one of the most important elements to check up and that as the asphalt was the most expensive ingredient of the pavement he would be more likely to find a shortage there than in any other constituent. In this instance he was drawing on his experience in concrete construction work.

In the second case, the engineer decided against complete inspection, but he or one of his assistants took a daily sample of the mixture and had a complete analysis made of it.

*Paper read before the Eighth Annual Conference on Highway Engineering at the University of Michigan on February 14, 1922.

In the third case, the engineer was convinced of the necessity of plant inspection and he assigned a good inspector to cover the plant, and had daily complete analyses made of the mixture but he thought the street gang could get along all right. This case is perhaps outside the limits of my subject but seems to me of sufficient importance to warrant the liberty of including it in my paper.

In the first case cited, a single sand was used and this sand had been examined carefully and approved as suitable for the construction of a sheet asphalt pavement. In the second case, two approved sands were used and they were supposedly mixed in the proportions designated by the engineer while in the third case, only one sand was used and there was practically no street inspection and the street gang was composed of unskilled and incompetent men. Still keeping the preliminary conditions in mind, let us inspect these roads after they have been completed and subjected to traffic for various periods of time.

First Road Examined.

In the case of the first road, the time will be four months. We find a small portion of it in excellent condition, a part of the remaining portion in scaling, badly, and the balance of the pavement is both wavy and scaly. Remember that this is only four months from the day this pavement was laid. This is no theoretical case. Quite recently I was over this particular pavement. Now, what really happened was this: An examination of the pavement from the different portions of the street showed very clearly that the portions of the pavement which were in fairly good condition carried about the normal percentage of bituminous material. The portions of the pavement that were scaling, instead of carrying between 10.5% and 11.5% bitumen carried on the average only 8.5%. The portion which was "shoving" had about 9% of bitumen. The analyses made by the engineer of this pavement all showed a bitumen content running between 10% and 11%, and, as you will recall, these samples were taken by the engineer on his daily visits to the street. It developed on further investigation that owing to the pressure of other work, the engineer regularly paid a visit to the street between 10 and 11 o'clock every morning. Therefore, the men at the plant and the men on the street, after that visit, knew there would be no further visits made that day and no other samples would be taken for analysis. It was very easy, therefore, for them to run during the early portion of the day, a mixture which contained the normal percentage of bitumen regardless of what they did afterward. It was also the case in this particular pavement that the contractor to whom the job was awarded was a man who had had a good deal of experience in public work, a man who stood very well with the administration, but this was his first attempt to lay a bituminous pavement. He was brought up in a school where anything to increase the output of the work could very often be gotten away with and such methods often did not seriously damage the final result, and being ignorant, he had to rely on the advice of the men he had hired for the job on the street and at the plant. They tried to make a low cost record for themselves by saving asphalt when they thought it would not be detected and by speeding up the plant.

Causes of Failure.

The deficiency in bitumen was one of the causes for the failure. Another cause was the fact that the pavement was insufficiently compressed, the rolling was done superficially, and the finished pavement had a density of between 1.85 and 1.89, which is much too low. An examination of certain portions of the pavement which were defective showed that not only was the bitumen content low but the grains of sand were insufficiently coated. That led to an investigation of the record as to the daily output of the plant. The plant had an ordinary 9 cubic yard mixer which turned out a batch of 1000 pounds of material. The specifications, backed up by the requirements of good practice, called for at least one minute's mixing in the mixer, the revolutions of the shafts between 60 and 80

per minute. An experienced mixing crew, trained to the last minute and entirely competent, can probably turn out one batch of mixture every minute and 20 seconds and give a full minute's mixing to each batch. An exceptionally well trained crew can, throughout the day, average one batch in 1 min. 30 sec. Giving the contractor the benefit of the doubt and assuming his crew to be an exceptional one, that would make 40 batches an hour. A thousand pound batch will lay 5 sq. yds. of 2-in. pavement, so the maximum output which could be allowed to a contractor doing his work properly and giving it the required time of mixing, would be 200 sq. yds. per hour.

In this particular case the work was prosecuted with a 9 hour plant day. That gives us 1800 sq. yds. per day as the maximum output for that plant. We found on investigating the records that 2500 or 2800, and even as high as 3000 sq. yd. had been laid per diem, which meant that the mixing was cut fully in half. That accounted for the insufficient coating of the sand grains. That, combined with the lack of rolling and the low percentage of bitumen, accounted entirely and wholly for the failure of that pavement in 4 months. The traffic on that road was heavy. The foundation was of concrete 8-in. thick and the subsoil was properly drained. There was no question of improper foundation or improper drainage. Further investigations involving a pretty close approximation of the daily amounts laid and their relative service records after the 4 months showed, in those cases where it was possible to trace them, which was about 30% of the time, that the pavement laid in the period from early morning up to 11 o'clock has given very good satisfaction. That illustrates as plainly as words can tell, what took place after the engineer had paid his daily visit and the contractor felt himself freed from further supervision for the balance of the day. An inspector at the plant would have verified the weights of the mixture. He would have verified the time allotted to mixing. He would not have permitted them to reduce it and the mixture sent to the street would have been of uniform bitumen content and his temperatures would have been properly maintained. The cost of that inspector at the plant weighed against the indirect cost to the city through the inconvenience to the public while taking up and replacing that pavement, and the cost of a new pavement which will fall directly on the contractor would have paid for ten inspectors at the plant ten times over.

Second Road Visited.

Now let us visit the second road. In this road two sands were used, one a coarse sand, and one a fine sand. In the fine sand the particles were almost wholly composed of quartz. They were very sharp and had rough surfaces to which bitumen adhered well. The coarse sand was partly rounded, and if used by itself would not have made a stable mixture. It was, however, the only coarse sand available in that location at anything like a reasonable cost and not more than 33% of it was required in the mixture. A mixture made according to these proportions would have had sufficient stability and was in all respects an excellent mixture. In this case you will remember daily samples were taken by the engineer on the street and the analysis that was made involved only the bitumen contents. The contractor was a man who had had very considerable experience in the laying of sheet asphalt, a man of high business honor and integrity and he tried honestly to lay the best pavement he knew how. The plant foreman was very good in some respects but slack in one particular. That one particular was fatal. Two years after that street was laid, possibly one-half of the pavement was in good condition and the balance was waving badly. The cause for the defective portions of the pavement was clearly traced to lack of care in the mixing of the sands. The established proportion for the sands was two of fine to one of coarse. Now, if you have had experience with asphalt plants, especially at the start of a piece of work, you will realize how very difficult it is to get men to keep their coarse sand piles separate from the fine sand piles

and establish a system whereby the sands will be mixed in the right proportion.

In this particular case the coarse sand was very much cheaper than the fine. The plant foreman, thinking to do his employer a good turn and reduce the cost to him of the pavement he was laying, tried to use all of the coarse sand possible. That policy was carried so far that possibly one-half of this pavement was laid with all coarse sand and no fine sand in it. The analyses showed that the bitumen content of that pavement ran uniform. The men on the mixer did their duty, using the same amount of sand and the same amount of filler and they kept the mixture uniform in these respects and the engineer congratulated himself that this pavement was more uniform than the average and he expected the best results from it. When we have a pavement with a given bitumen content composed of a large aggregate we have one in which the surface is more thickly covered with bitumen than in a pavement of the same bitumen content which is composed of a fine aggregate. In this particular case, when using the coarse sand alone, the mixture containing 10.5% bitumen probably carried over 1% excess of bitumen, which was further aggravated by the fact that the rounded grains had a comparatively smooth surface. The result was a pavement which markedly lacked stability and under heavy traffic it became wavy and shoved badly. In this case, the entire failure was due to not properly mixing the sands. An inspector at the plant who was competent and faithful would have kept an eye continually upon the men who were feeding the sand to the drum and would have seen that the coarse and fine sands were mixed in the proper proportion. Had he done so, that failure would not have occurred.

Third Road Inspected.

In the case of the third highway, which again was a main trunk line route, it also had a 6-in. concrete foundation and a subgrade more than ordinarily well drained, and only one sand was used. An inspector was present at the plant who was in every way competent. The analyses were complete and showed a mixture with a variation that was well within the average limits of departure from the standards set by the specification. In other words, the mixture was better than the average. The portions of the road that were laid in the early part of the season, showed at the end of two years a very decidedly wavy condition. Portions of the road which were laid toward the latter part of the season were as perfect at the end of two years, if not better than the day on which they were laid. Here was a case where the mixture was not at fault but what happened was this: In the early season the contractor had difficulty in getting a competent gang for the street. He had a poor roller man. He also had a four mile haul from the plant and the men who shovelled the material after it was dumped from the wagon were untrained and rakers and shovellers trampled upon the mixture while it was being spread. Complaint was made to the engineer having charge of the work of that very condition, but it appeared to be somewhat of a hardship to the contractor to expect him at the very start of the season to have a gang that was well trained and would fall into their places as they should. So, for a period of thirty days, workmanship on the street was tolerated which was not in accordance with the best practice but which would, possibly in 50 out of 100 cases, have resulted in an entirely satisfactory pavement. As is always the case, those portions of the street where the mixture had not been properly raked and fluffed up, contained places where the density of the pavement was greater than those parts immediately adjacent thereto, and when the roller passed over them there was left a pavement which did not have the same density throughout. The compression exerted by a heavy truck is greatly in excess of that which can be obtained with a steam roller and the concentrated traffic on that particular road found these spots that were less dense than others and began to depress them, and under modern motor traffic a depression once started quickly grows and gives

rise to other depressions until a series of waves is formed, with disastrous results which are familiar to us all.

The three roads in question were paved with sheet asphalt with 1½ in. of binder course and 1½ in. of surface mixture. In a normal sheet asphalt mixture, a total variation of 1½ % from the standard bitumen content desired is not necessarily fatal to the road or even extremely detrimental so that with this type of pavement a certain amount of inaccuracy in weighing the ingredients can be tolerated without specially bad results but in a great many sections of this country they lay what has been called Topeka mix, which is more or less of a hybrid. It was originally a sheet asphalt mixture containing a small percentage of stone, small enough in quantity and size to avoid the Warren Brothers' patents. The Warren Brothers had really covered the best possible grading for a coarse mineral aggregate in a bituminous pavement. There was great objection to laying a patented pavement and in order to get around that, they tried to lay this pavement which had only a small amount of stone in it. A great deal of this kind of pavement had been laid. Some of it has given very good results. In some cases its use has been justified by the fact that stone is cheaper than sand and the more stone the cheaper the aggregate will be and the less will be the amount of bitumen required, and, therefore, a considerable reduction in the cost of the pavement will be effected. The limit of variation in bitumen contents permissible in a Topeka mixture is, however, very much smaller than that which is permissible in a sheet asphalt mixture; therefore, more careful watching is required on the part of the platform mixing gang and greater accuracy in the weighing of the asphalt and the other ingredients of the batch.

When you think of men in a cloud of dust that at times is almost unbearably, turning out 40 batches an hour all day long, one wonders that they do as good as they do and it also becomes a matter of wonder how an engineer, having in charge a pavement involving 40 batches an hour separately weighed, could possibly go on without an adequate plant inspector and yet feel that the safety of the project was reasonably assured.

Temperature Tests.

There is another point which I would like to discuss, which was not involved in the case of these three roads mentioned, in order to illustrate another vital reason why an inspector should always be present at the bituminous mixing plant, and that is, the question of temperature. A test of the temperature of the mixture as it leaves the plant or as it reaches the street is not sufficient. In making the mixture we have two elements which are heated, the mineral aggregate and the asphalt cement. If we overheat the mineral aggregate and have a cool asphalt cement we have in the finished product a mixture which will come within the requirements of temperature but we will have injured the mixture because the mineral particles carry only a very thin film of bitumen and if heated beyond the danger point this thin film of bitumen will harden very rapidly. If, on the other hand, the sand or stone has been saturated with moisture by heavy rains the capacity of the drum for drying and heating the mineral aggregate will be reduced. Under such conditions, a foreman anxious to turn out a large output is tempted to overheat his asphalt to offset the low temperature of his heated aggregate, thus increasing the amount of mixture of normal temperature delivered by the plant. Such a mixture will be defective owing to undue hardening of the asphalt in the kettles and the bond between the bitumen and the sand will probably be weak.

In many cases, sand, which forms 75 % or more of a sheet asphalt pavement, is obtained from large pits that are operated by experienced men and they deliver a uniform supply which requires very little inspection to insure the use of suitable sand in the mixture. In other cases, the contractor frequently opens up his own sand pit. Often times stripping is required and the face of the sand pit is

found stratified, fine and coarse. Sometimes it is necessary to discard a layer 2 or possibly 3-ft. deep at the top in order to get a proper grading for the mineral aggregate. The contractor hires teamsters and places a man at the pit with a scraper and he instructs these teamsters to go to a certain portion of the pit and take the sand from there. The local teamster knows that the more loads he gets the better he will be paid and he takes the sand from the easiest or nearest part of the pit and the consequences are that half the loads should have been rejected. In other cases, where coarse and fine sand is mixed, it is very difficult to get the contractor to keep the sands separate. The drivers are careless and dump fine sand on the coarse pile and vice versa and there is no possible way of separating and grading the sands properly and the consequence is that the mineral aggregate varies so much that it does not come within the limit of the specifications or good practice, and, even if it does happen to fall within those limits, the variation is still so great that in order to secure the best results, the bitumen content should be varied. This it is impossible to do satisfactorily.

The asphalt cement in former days used to be made at the plant by fluxing a hard asphalt with flux but today most of the large asphalt manufacturers send tank cars that are tested, either before they leave the plant or on delivery, and the variations in penetration are very trifling and do not require to be tested more than once per tank car delivery instead of once for every kettle filled at the plant unless the contents of the kettles are kept under heat for a very long time.

BRITISH FIRM CELEBRATES CENTENARY.

THOMAS Piggott & Co. Ltd., Birmingham, England, who recently celebrated their centenary, are one of the leading concerns in England engaged in the manufacture of steel pipe and tanks. The company was first organized to build iron canal-barges but developed other fields of activity until 1880, when manufacture of steep pipe and tanks was undertaken; being one of the pioneers in that particular line. Thomas Piggott & Co. do not confine their efforts to the home market, but have developed an extensive foreign connection and have completed several important contracts in various parts of the world. One of the first contracts they secured was in Kimberley, South Africa, where they laid down some ten miles of 14 in. and 18 in. water mains. For Sydney, Australia, this company supplied steel pipe up to 8 ft. diameter for water mains, for crossing a number of wide creeks and these were erected and worked in spans of 50 ft. without any trussing. Thomas Piggott & Co. designed and erected the first canal for the irrigation works in Egypt. The canal consisted of a semi-circular steel culvert 19 ft. 8¼ in. diameter by 5,185 ft. long. Later they supplied a riveted steel main 6 ft. 6¼ in. diameter by 3,100 ft. long.

TOWN PLANNING COMMITTEE FORMED.

PREMIER Drury announced in the Legislature last Thursday the personnel of a committee on town planning, which will meet during the recess and report at the next session. The members announced were: Hon. Walter Rollo, West Hamilton; Hon. G. S. Henry, East York; C. S. Swayze, Niagara Falls; J. B. Cunningham, Sault Ste. Marie; Edgar Watson, North Victoria; A. G. Tisdelle, North Essex; Joseph Thompson, Northeast Toronto; Jack Ramsden, Southwest Toronto; J. A. Pinard, East Ottawa, and G. G. Halcrow, of East Hamilton.

The Engineering Equipment Co. Ltd., Montreal, have recently been appointed as exclusive Canadian sales representatives for Schutte & Koerting Co., of Philadelphia, manufacturers of low level jet condensers and other power plant equipment.

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INDEFINITENESS IN SPECIFICATIONS.

INCALCULABLE annoyance and friction in the smooth relationship of engineer and contractor arises through the lack of definiteness in specifications. If, as frequently happens, those things which the contractor is supposed to do in return for his compensation, are left unspecified or left to the discretion of the engineer, there is bound to be, sooner or later, a dispute of more or less serious character. Apart from the normal difference of opinion that may exist between the two parties to the contract there is the temptation for one or other party to exact more than was intended in the contract if the character of the work be not positively specified.

Two causes, perhaps, lie behind the lack of definiteness in specifications. There is first the occasional lack of knowledge of the engineer concerning the work or detail being described. Under such circumstances he is disposed to require that the work be to the satisfaction of the engineer, or as the engineer may direct, or merely proper and sufficient. Anyone of these is entirely unsatisfactory, to say the least, and it is difficult to see how the work could be carried out without dispute under the specification containing stipulations of this kind.

Another cause of indefiniteness is carelessness and habitual lack of precision. The engineer may be experienced and may have a proper conception of what might reasonably be required, but through the habit of copying old and faulty specifications, or through mental indolence neglects to state exactly in quantitative or qualitative terms the characteristics of the work that is to be finished. For example, in a recent specification for concrete it is stated

that the maximum size of "one-man stone" shall not exceed that which one man can lift and readily move about. Here is an opportunity for dispute which is properly guarded against in another specification where the maximum size of such stones is fixed at 100 lb. weight. Other specifications have been known to require that concrete be not dropped from a height, without definition of the latter term; that stones for the aggregate be as nearly cubical as possible; that timber be free from knots, regardless of the expense involved in furnishing such timber; that sewer pipe be free from cracks and blisters, a condition that would be realized in only a very small percentage of pipes produced; that a wall be given a mortar coating, without specification of either composition or thickness; or that the surface of a concrete pier or abutment be finished in a manner to be specified later by the engineer.

Whatever the causes of such lack of precision in specifications may be, there can be no difference of opinion as to the undesirable results attending it. Engineers should exert every effort to insure that whatever is specified is described in a definite numerical or qualitative way.

CREATION OF URBAN AREAS.

NO achievement of the engineer impresses the public more than additions to the area of the earth's surface. In such work creative engineering is seen at its best. Even the most unobservant are disposed to view with admiration the work of one who adds valuable acres to an already congested city area.

Of such work there are numerous examples both in this country and abroad. The admirable achievement of the Toronto Harbor Commission in adding a large industrial area to the city through the reclamation of Ashbridge's Bay is familiar to most people in Canada. Similar developments, of less spectacular character, are under way in other parts of Canada.

Perhaps the most amazing reclamation project planned to create additional urban acreage is that proposed for the extension of Manhattan Island by Dr. T. Kennard Thomson, a Canadian-born engineer, who has for many years been resident in New York. To relieve the extreme congestion of lower Manhattan and to maintain the present centre of the down-town business district, it is proposed to extend Manhattan some six miles down the bay by the process of filling in the shallow waters to the south of the Battery. By so doing 3,840 acres of land would be created, 12 lineal miles of new wharves would be possible, and by means of tunnels, Staten Island would become accessible to the Manhattan extension as Brooklyn now is to Manhattan proper. Revolutionary methods of transit would be adopted as a feature of the plan, the streets having four levels, the bottom one being for sewers, pipes and wires only, the second for heavy trucking and belt line railroads, the third for rapid transit and the fourth for light motor traffic. Arrangements would be made for freight and express cars to unload directly on motor trucks which would give the much desired store delivery.

So extensive is the project that some people are disposed to say that it is not in the realm of the immediately practicable. Granted that the work were carried out, it is very probable that the addition of six square miles of new territory to Manhattan Island with tremendous accruing advantages would ultimately justify the expenditure. It is calculated that the addition to the city's assets in the way of taxable land, buildings, docks, and the like, would be some \$5,000,000,000. Those who are supporting Dr. Thomson in the project express the view that the commercial advantage to the city would be sufficiently great to warrant great efforts being put forward to carry it to realization.

While no such astounding development presses upon the attention of Canadian cities, the extent to which engineers and business men are disposed to go to relieve undesirable building and traffic situations in the larger cities

of this continent affords a suggestion for us when disturbing conditions of area and transportation arise. Under such circumstances a bold and almost visionary policy appears to be the soundest.

PERSONALS

HOWARD W. TYE for nearly twenty years construction engineer for the Canadian Pacific Railway has been appointed superintendent of the Alberta Provincial Railway, the Lacombe and Northwestern.

N. H. BRADLEY has been appointed as District Surveyor and Engineer for the Peace River District, Department of Public Works of Canada. Mr. Bradley was formerly assistant engineer at Lethbridge, Alta. His new headquarters are at Edmonton.

JAMES EWING, E. S. M. LOVELACE and ALTHEOD TREMBLAY, who have been in partnership for several years in Montreal under the firm name of Ewing, Lovelace & Tremblay, civil engineers and land surveyors, have dissolved partnership. Messrs. Lovelace and Tremblay have formed a new partnership under the title of Lovelace and Tremblay, while Messrs. Ewing and Tremblay have formed a separate partnership under the name of Ewing & Tremblay. Both new firms are occupying offices at 14 Phillips Square, Montreal. Mr. Tremblay, who is a member of the Board of Quebec Land Surveyors, is a professor at Laval University. Mr. Lovelace is a graduate of McGill University (gold medalist), class of 1888, and has had long experience as a surveyor and municipal engineer in the province of Quebec. Mr. Ewing is vice-president of the Town Planning Institute of Canada, and has had extensive experience in railway, civil engineering and town planning work, and has been the consultant on several town planning enterprises in the last few years. He is an expert draftsman, having been formerly chief draftsman of the Canadian Pacific Railway Co., and has been responsible for the preparation of a number of Canada's most valuable maps now in use in railway and other work.

LT.-COL. HAROLD L. TROTTER, who recently entered private practice as a consulting engineer, opening an office in the New Birks Building, Montreal, was born in that city in January, 1883, and was educated at the St.

Johns High School, St. Johns, Que., the Abingdon School, Montreal, and the Royal Military College, Kingston, where he graduated in June, 1903. For the following eight years he was employed by Ross & Holgate, consulting engineers, Montreal, and while with that firm he was engaged on a great variety of work, chiefly hydro-electric and reinforced concrete, both in the field and in the office. In 1911 when the firm of Ross & Holgate, was dissolved Col. Trotter remained with Mr. Holgate and was with him as an associate until March 1915, when he joined

and served in that capacity until the end of the war, being promoted to the rank of Lieutenant-Colonel in command of the 11th Battalion, Canadian Engineers, in May, 1918, when the engineer units were reorganized. Lt.-Col. Trotter was mentioned in dispatches on three occasions, and he received the D.S.O. He returned to Canada in June, 1919, and after three months on a road contract at Revelstoke, B.C., he became chief engineer for Morrow & Beatty, general contractors, Peterboro, Ont., on the construction of a new power plant for the Abitibi Power & Paper Co. at Twin Falls on the Abitibi River. Upon the conclusion of this work Col. Trotter decided to enter private practice, and opened his present office in March of this year. Lt.-Col. Trotter has been an associate member of the Engineering Institute of Canada since 1907, and was recently transferred to the rank of member.

MORE SPEAKERS AT GOOD ROADS CONVENTION

SEVERAL additional speakers have notified the executive of the Canadian Good Roads Association that they will participate in the ninth annual convention to be held in Victoria, B.C., from June 12 to 15, and it is evident that while there will be some entertainment during these four days for the delegates, they will have full occupation for their time in the sessions of the convention, and the principal tours, etc., that have been organized by the reception committee will have to be carried out on the Friday and Saturday after the close of the business proceedings, so that delegates may count on a full week in Victoria, and as much longer as they desire to stay on the mainland. The Good Roads convention is essentially a business gathering, and the executive are allowing nothing to interfere with the program as drawn up. They have extended the meetings from three days to four, feeling that with delegates coming from such long distances the fullest opportunity must be taken of diffusing knowledge on highway matters to them, and a program of speakers without parallel has been arranged for this purpose.

Premier Bell, of Prince Edward Island, has notified the President, the Hon. Sam J. Latta, that he will head the delegation from the eastern extremity of the Dominion, while R. H. Murray, president of the Nova Scotia Good Roads Association will head the group of road enthusiasts from Nova Scotia. From New Brunswick, R. Downing Patterson, of the Good Roads Association in that province will bring several delegates, while Premier Taschereau has informed the Hon. Mr. Latta that while it will be impossible for him to make the journey, the Hon. J. L. Perron, Minister of Highways, and several of the Quebec Government officials will do so. The Ontario Government will also be represented, as well as many of the good roads and automobile organizations of that province. The city of Ottawa is sending one of its controllers as well as A. MacCallum, Commissioner of Works. The subject of the address by A. W. Campbell, Federal Commissioner of Highways, will be "Federal Aid, its implications and results," while Professor Greig, of the University of Saskatchewan will give the address on drainage methods for prairie roads, with H. R. Mackenzie, chief field engineer of the Province of Saskatchewan will open the discussion on this subject. C. A. Mullin of Montreal will speak on asphaltic concrete pavements, while Russell T. Kelley, of Hamilton, vice-president of the Canadian Good Roads Association, and G. Webster, of Calgary, Alta., will lead the discussion on "Tourist Traffic." It is almost certain that A. P. Sandies, of Columbus, Ohio, one of the outstanding figures at previous conventions will be present and give a practical address on highway matters.

The Toronto party of delegates to the Canadian Good Roads Association Convention at Victoria will leave Toronto on the Trans-Canada C.P.R. train at 9 p.m. standard time, June 6. The dates of the convention are June 12 to 15.



the Canadian Engineers. For the remainder of that year he was employed under the C.R.C.E. at Quebec, and in March, 1916, he went overseas. He went to France with the 4th Canadian Division in August, 1916, as major in command of the 11th Field Company, Canadian Engineers,

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Toronto, Ont., installation of one four-million Imperial gallon centrifugal pump at Island Pumping Station....	June 13	May 9
Nassau, New Providence, Bahamas, dredging	July 15	May 9
Revelstoke, B.C., construction of bridge	Jun. 19	May 23
Westminster Junction, B.C., construction of steel highway bridge	Jun. 10	May 23
St. Catharines, Ont., Sections 3 and 4 combined, Welland Ship Canal ..	Jun. 9	May 23
Birch Cliff, Ont., construction of concrete sidewalks	Jun. 12	May 30
Revelstoke, B.C., substructure of bridge	Jun. 19	May 30
Saskatchewan, Province of, construction of earth road from Canora south to Burgis	Jun. 8	May 30
Saskatchewan, Province of, construction of earth road from Kamsack north six miles	Jun. 8	May 30
Walkerton, Ont., construction of pavement	Jun. 12	May 30
Oakville, Ont., additions and alterations to Methodist Church Sunday School	Jun. 15	May 30
Ottawa, Ont., construction of power house, Ottawa Civic Hospital	Jun. 13	May 30
Ottawa, Ont., construction of female help building, Ottawa Civic Hospital	Jun. 15	May 30
Timmins, Ont., four-room addition to public school	Jun. 10	May 30
Toronto, Ont., construction of concrete structures	Jun. 14	May 30
York Tp., Ont., construction of sidewalks and pavements	Jun. 10	May 30
Kingston, Ont., construction of dairy building	Jun. 10	May 30
McKillop Tp., Ont., construction of drain	Jun. 13	May 30
Ottawa, Ont., erection of addition to school	Jun. 8	May 30

ROADS, BRIDGES AND STREETS

Alberta, Province of.—A survey is being made of a section of the Jasper Highway between Evansburg and Lobstick junction, a distance of seven miles. It is understood that the completion of the road up to this point will be proceeded with on the government's road building program this summer.

British Columbia, Province of.—Approximately \$1,500,000 will be spent on highways this year, Hon. W. H. Sutherland, Minister of Public Works, announced. The work includes the Pacific Highway paving in the municipality of Surrey; the Nelson-Ymir Road, \$80,000; Cascade-Rossland Road, \$230,000; roads in Similkameen district, \$80,000, Columbia Valley work, \$62,000; Yellow Head Pass project, \$68,000, etc.

Coquitlam, B.C.—The C.P.R. bridge over the Coquitlam river, which was washed away last year by floods, is now being replaced by a modern structure at a cost of \$172,000.

Galt, Ont.—A 12-in. drain will be built on the Roseville Road, Waterloo County, for a distance of 400 ft., and other improvements made to the road. Improvements will also be made on Blair Road. Road Supt., L. S. Lichty, Wellesley, Ont.

Guelph, Ont.—McNamara Bros. & Thornton have been awarded contract for construction of pavement from end of pavement on Elora Road out towards Marden.

Kamloops, B. C.—Local Board of Trade is trying to secure action by the Provincial Government in respect of the extension of the North Thompson Road to Tete Jaune Cache and through to the inter-provincial boundary.

Milton, Ont.—By-law providing for extension of concrete walks was carried by ratepayers. Clerk, G. A. Hemstreet, Milton West.

New Brunswick, Province of.—Hon. P. J. Veniot, Minister of Public Works, awarded contract for construction of the Copp concrete arch culvert and roadway embankment in Parish of Sackville to John W. McManus Co., Ltd., at approximately \$8,000, and contract for Little River Mouth bridge, Parish of Bathurst, was awarded to Whitman Brewer, of North Devon, at approximately \$13,000.

Newmarket, Ont.—Contract let to Warren Bituminous Paving Co. of Ontario, Ltd., Toronto, for paving of certain streets, approximately 12,000 sq. yds.

Newmarket, Ont.—Town Council decided to spend \$70,000 on pavements for Prospect St., Church St., Park Ave. and Timothy St. Clerk, P. J. Anderson.

Ottawa, Ont.—Railway committee of House of Commons passed the bill to permit the Niagara River Bridge Co. to enlarge, alter or remove its present bridge across the Niagara River and among other things to permit increase of its capital stock from one million to two million dollars.

Ottawa, Ont.—Following contracts were awarded by Carleton County Council: Steel work, Porteous bridge, \$3,446, and steel work, North Gower bridge, \$1,344, to Ontario Bridge Co.; about three miles of bituminous penetration work on Richmond Road, McDonnell, Dibblee & Co.; work on Cyrville Road (about 1 mile) work on Base Line Road (about ½ mile), Ormond & Brule; Carp Village and Osgoode Station Roads, W. J. Farmer. Patterson & Byrne, County Engineers, were instructed to call for tenders for superstructure of Porteous and North Gower bridges.

Palmerston, Ont.—Contract for construction of pavement awarded to W. C. Brennan & Co.

Pikington, Ont.—Contract for construction of a 36-ft. bridge and abutment for steel bridge awarded to McNabb & Callaghan, of Arthur, Ont.

Quebec, Province of.—Tenders will be called by Highway Dept. for Quebec-Ste. Anne Highway. Minister, Hon. J. L. Perron.

St. Catharines, Ont.—City Council awarded following contracts: To A. Longley, of St. Catharines, 9,600 lin. ft. of concrete sidewalks; Newman Bros. and A. Longley, St. Catharines, 6,000 sq. yds. concrete pavement; Newman Bros. and A. Longley, 10,000 sq. yds. concrete foundation with curbs and gutter.

St. Thomas, Ont.—The question of seeking the co-operation of the London City Council and other influential bodies of that city in petitioning the Provincial Department of Highways to adopt the London and Port Stanley Gravel Road into the Provincial Highway System and proceed with

paving operations, is under discussion in this city and it is probable that action will be taken in the near future.

Sarnia, Ont.—Road improvements are planned on several roads in Lambton County, including the roads running through the Beehive corner, Kimball and Wilkesport. Road Supt., John McCallum, Alvinston.

Saskatchewan, Province of.—Tenders will be received until 4 o'clock, Monday, June 19, for concrete bridges. (See official adv.).

Thamesville, Ont.—Provincial Highway Dept. plans to take over the Longwoods Road in this village.

Thamesville, Ont.—Contract awarded to Merlo, Merlo & Ray, of Walkerville, for construction of pavement on Base Line, at \$2.63 per sq. yd.

Toronto, Ont.—Several streets in Victoria Park will be graded.

Toronto, Ont.—City Council intends to construct concrete curbs on Runnymede Road and Walpole Ave., at a cost of \$3,124; also asphalt pavement on Runnymede Road, at cost of \$49,004.

Toronto, Ont.—City Council took first step towards the widening of Bloor St., from Sherbourne to Spadina Ave., by ordering the filing of a plan of the work in the Registry Office. Estimated cost, \$1,500,000.

Vancouver, B.C.—City Council approved an expenditure of \$195,000 on street improvements, work to be done by day labor. City Engineer, F. C. Fellowes.

Whittemouth, Man.—Rural municipality of Whittemouth proposes to pass a by-law for the opening and construction of a roadway. Sec.-Treas., Charles Pound.

WATER, SEWAGE AND REFUSE

Edmonton, Alta.—Tenders were received by the City Commissioners until June 5 for approximately 12,300 lin. ft. of sewers in Highlands subdivision, and for approximately 16,000 lin. ft. of watermain in Bellevue and Bellevue addition. Commissioner, C. J. Yorath.

Galt, Ont.—City Council intends to construct a sanitary sewer on Blair Road and Samuelson St., at an estimated cost of \$11,528.11. City Clerk, Joseph McCartney.

Galt, Ont.—City Council intends to construct a sanitary sewer on Chalmers St., from Dundas St. to McNaughton St., at an estimated cost of \$3,343.74.

Guelph, Ont.—Provincial Board of Health has approved of proposed sewerage work to be done by the city on Waterloo Ave. City Engineer, F. McArthur. Estimated cost, \$43,195.

Hamilton, Ont.—Contract for construction of pipe sewers in King William, Stirton, Dalhousie and Gore Streets and Campbell Ave. awarded to John Maguire Contracting Co., Ltd., Toronto, at \$187,433.80. W. R. Worthington, Toronto, also submitted a tender at \$249,298.93.

Milton, Ont.—By-law providing for water mains was passed by ratepayers. Clerk, G. A. Hemstreet, Milton West.

Montreal, Que.—City Council decided to spend \$6,000 for water meters for Cote de Neiges district.

Montreal, Que.—Contract for sewer on St. Urbain St., costing \$11,154, was awarded by City Council to C. Frascarelli & Co.

North Grimsby Tp., Ont.—Tenders, addressed to Thos. Allen, Township Clerk, Grimsby, Ont., will be received until 6 o'clock p.m., Saturday, June 10, for the following material and work: (1) Supply of 20,000 ft. of 6-in. class C, C. I. pipe and specials; (2) valves, valve boxes and hydrants; and (3) trenching, laying and backfilling. Engineer, F. N. Rutherford, 24 Queen St., St. Catharines, Ont.

Quebec, Que.—J. A. Tremblay, chief engineer of the Waterworks Department, is now ready to call for tenders for the trenching and refilling that will be involved in connection with the extension of the water and drainage system of the city for the sections recommended for these improvements by the City Council. These include Belvedere, Marquette, Champlain and the Q.A.A. grounds.

St. Catharines, Ont.—City Council awarded contracts for sewers to Peter Mohan, of London; Mitchell Contracting Co., of London; and Sacco & Lorenzo, Niagara Falls, Ont.

Thorold, Ont.—Tenders, addressed to B. R. Noble, Secretary, Public Utilities Commission, will be received until 6 o'clock p.m., June 15, for the following material and work: (1) Supply of 4 and 6-in. class B, cast iron water-pipe and specials; (2) 4-in. and 6-in. valves and valve boxes; (3) hydrants; (4) 9.640 ft. of trenching. Information may be obtained from Engineer, F. N. Rutherford, 24 Queen St., St. Catharines.

Toronto, Ont.—Contract for construction of sewer in Margueretta St. awarded to Commissioner R. C. Harris at \$43,900.

Toronto, Ont.—Contract for laying and jointing of 6-in. water pipes in Durie St. and Firstbrook Road awarded to W. E. Taylor.

Toronto, Ont.—City Council ordered the construction of a sewer on Mount Pleasant Road, between Heath St. and St. Clair Ave.

Toronto, Ont.—Contracts for construction of sewers—Western Harbor Development Drainage System—awarded as follows: Section 1, 2,000 ft. east of Parkside Drive to 1,475 ft. farther east, Commissioner R. C. Harris, \$24,532; Section 2, Parkside Drive to Windermere Ave., W. R. Worthington, \$114,443; Section 3, Windermere Ave. to Jane St., W. R. Worthington, \$5,869.

Welland, Ont.—City Engineer Chas. L. Coulson has prepared plans for sewers in Queen St. West and Margaret St., and City Clerk Forster will advertise for tenders at once. Petitions for similar construction in Bald St., west of the N. S. & T., and Major St., east of Myrtle Ave., are in the hands of the City Engineer.

Windsor, Ont.—City Council let contract for laying a short stretch of sewer on Huron St. to Pettypiece's, Ltd., of Amherstburg, Ont.

LIGHT, HEAT AND POWER

British Columbia, Province of.—Contracts for four 54-in. pumps which are to be installed at the Sumas dam, to drain Sumas Lake, have been awarded to the Dominion Engineering Works, Ltd., Montreal, by the B. C. Land Settlement Board. The pumps, which have a capacity of 750 second ft., are driven by individual motors, which will be of approximately 600 and 1,200 h.p., two of each being installed. The contract was let through C. A. Yowill, of Vancouver, and delivery is promised for February, 1923.

Durham, Ont.—At a recent meeting held here of the Hydro-Electric Power Commission of Ontario and the municipalities linked up with the Eugenia system, it was stated by Engineer Jeffery that in order to increase the power at Eugenia, three schemes were being considered by the commission: Linking up with Niagara, putting in a pipeline or developing the Saugeen River near Burgoyne, Ont.

New Liskeard, Ont.—Reference was made in this column in our issue of May 23 to commencement of work on 6,000 h.p. development at Indian Chutes on the Montreal River, twelve miles above the town of Elk Lake, for the Matachewan Power Co., Ltd., the engineers for which are Sutcliffe & Neelands, Ltd., of New Liskeard. Announcement has now been made of the board of directors of the company as follows: President, Robert Fennell, Toronto; 1st vice-president, F. J. Westaway, Hamilton; 2nd vice-president, Col. Robert Stark, Montreal; D. W. Caldwell, Perth; Sir Henry Galway, D.S.O., London, Eng.; and H. W. Sutcliffe, New Liskeard. The completed plant, which will produce 13,000 h.p., will supply power to the Kirkland Lake, Elk Lake, Gowanda and Shining Tree mining camps. The company, which is capitalized at \$1,000,000, has the power rights on the Indian Chutes and Big Ben, on Montreal River. Work has already commenced and orders for machinery will be placed at once.

Ontario, Province of.—Included in the supplementary Hydro estimates is an item of \$20,000 for preliminary engineering and reconnaissance work in connection with a

new trunk line from Queenston to St. Thomas. \$90,000 is included for the completion this year of the installation of four 50,000 k.v.a. transformers; Kent station, \$20,000; Guelph, \$40,000; Essex, \$140,000; Stratford, \$36,000; and Preston, \$36,000, all of these being for increased capacity.

Winnipeg, Man.—City Council let contract for supply of 3,000 k.v.a. transformers to the Canadian Westinghouse Co., of this city, at \$10,370.

RAILWAYS

Alberta, Province of.—Contract for preliminary construction work on 12-mile extension of the Lacombe Northwestern Railway has been awarded by the Provincial Department of Railways to W. A. Dutton. Estimated cost of completed road, \$250,000.

Alberta, Province of.—Tenders are being called for by the Railway Department on the construction of a 12-mile extension on the Lacombe Northwestern Railway. The engineering work will be under the supervision of Capt. Howard Tye. Minister of Railways, Hon. V. W. Smith.

Alberta, Province of.—Tenders are being called for several pieces of construction in Alberta by the Canadian National Railway. A connection between the Canadian Northern and the Grand Trunk Pacific at Magnolia, a distance of .83 miles; a connection between Bashaw and Battle River subdivisions, 3.47 miles long, near Camrose, and a connection at Ryley, 1.83 miles long, between the Viking and Battle River subdivisions are to be constructed. The plans and specifications may be seen at the office of the district engineer in Edmonton and the division engineer in Calgary.

Galt, Ont.—General Manager M. W. Kirkwood of the G.R.R. and L.E. & N. Ry., has received from Montreal the revised plans for the new depot to be erected on Main St.

Stratford, Ont.—Grand Trunk Railway plans to greatly enlarge their repair shops here at an approximate cost of \$1,000,000.

FACTORIES AND LARGE BUILDINGS

Alliance, Alta.—A \$100,000 fire destroyed an entire business block on the main street.

Bramford, Ont.—Tenders for plumbing required for the Alexandra and Victoria Schools will be received by A. K. Bunnell, Secretary, until Thursday, June 8. Specifications will be furnished by G. W. Broomfield, plumbing inspector, at office of City Engineer.

Bridgeburg, Ont.—St. Paul's Anglican congregation will construct a parish hall on corner of Emerick and Central Avenues. Rector, Rev. Canon D. R. Smith.

Brockville, Ont.—Contracts awarded to J. A. Grant & Co., Ltd., of Montreal, for construction of rod rolling mill and electrical sub-station for Eugene F. Phillips Electrical Works, Ltd.

Calgary, Alta.—School Board sold an issue of debentures amounting to \$280,000 for the erection of a Normal school and various small buildings.

Calgary, Alta.—The Baird Construction Co. who obtained the contract for the new service building at the General hospital, have started work.

Calgary, Alta.—Board of Trustees of Calgary School District No. 19 of the Province of Alberta proposes to apply to the Board of Public Utility Commissioners for authority to borrow \$140,000 for the purchase of the Pryce Jones property for \$105,000, and for repairs and alterations to same at a cost of \$35,000. Secretary, D. C. Bayne.

Chatham, Ont.—E. B. Lawler, district engineer of the Hydro-Electric Power Commission of Ontario, has completed plans for a transformer sub-station to be erected in South Kent near the village of Fletcher.

Dutton, Ont.—Tenders will be received by Barrach & Findlay, Architects, 130 Talbot St., St. Thomas, Ont., until Wednesday, June 7, for the erection of a Memorial Hall.

Ford, Ont.—Separate School Board awarded contract to Cleveland Mousseau for construction of three-roomed separate school on Janisse Ave., at \$5,000.

Hamilton, Ont.—Kanadda Biscuit Co. plans erection of plant. Architects, B. H. Prack and A. E. Prack.

Halifax, N.S.—The M. E. Keefe Construction Co. have been awarded contract for addition to Monastery of the Good Shepherd, Quinpool Road.

La Fleche, Sask.—Contract for erection of Roman Catholic church awarded to Sam Pritchard, of Moose Jaw, at \$35,000.

Leamington, Ont.—Erection of new Baptist Church building is projected.

Lindsay, Ont.—Board of Education accepted plans and specifications submitted by Sharpe & Horner, Architects, of Toronto, for proposed alteration and extension to Collegiate Institute. Architects were instructed to advertise for tenders.

London, Ont.—Plans of the new arts college building of Western University have been approved and tenders will be called for within a few days.

Mailardville, B.C.—Coquitlam School Board awarded following contracts for repairing municipal schools: Building new foundation at Millside School, Philip & Shaw, New Westminster; repairs to Blue Mountain School, Spring & Sibley, New Westminster; plumbing at Millside and Blue Mountain schools, James & McClughan, Ltd., New Westminster.

Milton, Ont.—By-law providing for improvements to Town Hall was passed by ratepayers. Clerk, G. A. Hemstreet, Milton West.

Newmarket, Ont.—Town Council considering erection of school at cost of \$54,000.

Ottawa, Ont.—Tenders were received until June 2 by the Ottawa Hydro-Electric Commission for structural steelwork for a substation to be erected. General Manager, J. E. Brown.

Port Arthur, Ont.—City Council passed by-law providing for raising of \$200,000 for erection of public school on Prospect Ave. City Clerk, T. F. Milne.

Port Arthur, Ont.—City Council passed by-law providing for raising of \$7,500 for construction of arena in Current River Park. City Clerk, T. F. Milne.

Preston, Ont.—George Mather was awarded contract for new ward school to be erected on Moore St., at \$36,798, including all trades except heating, plumbing and ventflating.

St. John, N.B.—Fire on the premises of the St. John Drydock & Shipbuilding Co. destroyed the roundhouse and one locomotive, a building owned by the Bedford Construction Co., a compression outfit owned by the Drydock company and stores, valued at \$20,000. Total loss, \$30,000.

St. Laurent, Que.—Contract for erection of schoolhouse has been awarded to G. Carta.

Saltfleet Tn., Ont.—Tenders were received until June 5 by R. H. Dewar, Secretary, School Board, Fruitland, Ont., for erection of addition to school building in S. S. No. 2, Saltfleet.

Sherbrooke, Que.—Tenders were received until June 5 by J. W. Gregoire, Architect, for the building of a school in the West Ward for the Catholic Board of School Commissioners.

Toronto, Ont.—Board of Education has purchased a school site in Leslie Gardens. It is expected that a school of six or eight rooms will be built this year.

Toronto, Ont.—Tenders, bulk or separate, will be received until noon, Thursday, June 8, for the erection of a Sunday School Building at the corner of Greenwood Ave. and Globeholme Boulevard. Architects, Wlekson, Gregg & Brydon, 1112 Temple Bldg.

Vancouver, B.C.—A plant is to be established here by the Canada Wire & Cable Co., of Toronto. General Manager, H. Horsman.

Welland, Ont.—Public Library Board has been notified of the appropriation by the Carnegie Foundation of \$25,000

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Pumping and Filter Plant at Sturgeon Falls, Ont.

Supply Drawn From Sturgeon River by Two 6-in. 2-Stage Centrifugal Pumps—Three Horizontal Pressure Filters—New Pump and Filter House and Water Tower—Cost of Work, \$80,000.

RECENTLY there was put into service a much needed pumping and filter plant for the Town of Sturgeon Falls, Ont. This community, having a population of 4,000 now draws its water supply from an intake in the Sturgeon River. The quality of the water obtained is excellent and provision is made for a domestic pressure of 70 lb. per sq. in. and a pressure for fire service of 120 lb. per sq. in. by the new improvements. The pump and filter house, the water tower and the pumping and filter equipment are illustrated in Figs. 1 to 3.

Intake.

Water is drawn from the Sturgeon River by means of a rectangular reinforced concrete intake chamber 6 ft. by 11 ft. 6 in. and 9 ft. deep. The bottom of the intake is 18 in. below low water level and the top is just above high water level. This box, of which the exterior walls consist of 12 in. of reinforced concrete is divided into two compartments by an 8-in. vertical division wall. In this dividing wall there is an 18-in. sluice gate, making it possible to cut off the water from the compartment in which the intake pipe is located. The latter, which is of cast iron and 10 in. in diameter, is provided with a strainer at the lower end. In the opposite compartment an opening 2 ft. 6 in. by 3 ft. 6 in. is provided in the down stream outer wall for the admission of water. To protect the intake from debris, a vertical deflecting wall is constructed between the intake and the shore. The outer walls of the intake chamber are reinforced by $\frac{5}{8}$ -in. dia. horizontal round rods spaced 12 in. centre to centre vertically. The top of the

stage centrifugal pumps, direct connected with flexible coupling to 100-h.p. Westinghouse constant speed motors of the 3-phase, 60-cycle, 555-volt type having a speed of 1740 r.p.m. The pumps have a capacity of 1350 U.S. gal. per min. against a head of 180 ft. for domestic purposes and 1080 U. S. gal. against a head of 225 ft. for fire pur-



FIG. 2—PUMP AND FILTER HOUSE AND ELEVATED TANK

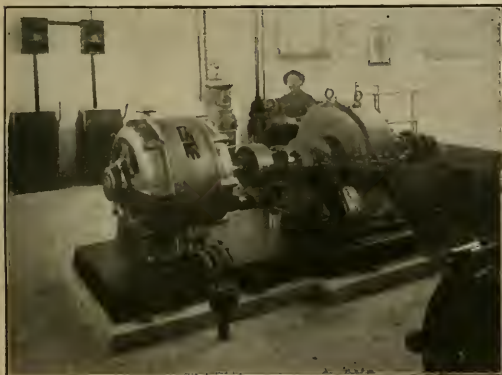


FIG. 1—PUMPING UNIT IN OPERATION

intake is covered by a 3-in. concrete slab and contains an 18-in. manhole for each compartment.

To provide the necessary supply of water for the town there have been installed in the pump house two 6-in., 2-

poses. They have bronze impellers and a brass covered shaft. One of them with its motor is shown clearly in Fig. 1. The location of these pumps in the pump and filter house is indicated in Fig. 3.

Filters.

After some study it was decided to instal for purification purposes three horizontal pressure filters 8 ft. in diameter and 10 ft. long giving a total filter area of 270 sq. ft. and a capacity of from 600 to 1200 gal. per min. The filter tank shells are designed for a working pressure of 100 lb. per sq. in. They each rest on two concrete cradles 12 in. wide and 7 ft. 6 in. long, as shown in Fig. 3. Each filter contains $2\frac{1}{2}$ ft. of sand overlying 14 in. of gravel. These materials were brought from the Atlantic Coast and are known as the Cape May variety. The collector pipe tapers from about 4 in. at the dead end to 6 in. at the delivery end. Branching off from this in both directions horizontally are $1\frac{1}{2}$ -in. cast iron laterals spaced $10\frac{1}{2}$ in. centre to centre. Brass strainers connect to the laterals at distances of 7 in. apart. The collector pipes and laterals rest on a bed of grout carried up to the level of the top of the laterals.

Raw water is supplied to the three filters through an 8-in. flanged cast iron pipe provided with Chapman gate

valves. The filter water is drawn off through a 8-in. cast iron pipe similarly equipped. The filter contractor supplied all interconnecting piping for the three units above the floor line and on each wash discharge a cast iron funnel to be set in the floor, making connection with a 10-in. Akron tile line furnished and laid by the town.

Pump and Filter House.

To house the pumping and filter equipment, the building shown in Fig. 2 was constructed. This consists of a two-storey brick building 22 ft. by 40 ft. with a one storey attached portion 22 ft. by 29 ft. 6 in. The chief operator lives over the pump house and his assistants work on eight-hour shifts making a very easy and satisfactory arrangement for the operation of the station.

Alum Supply.

A small coagulant feed for the alum is connected to the main between the pumps and the filters. As yet the town has not resorted to chlorination, as the water is clear and pure enough not to require this treatment.

Power.

The town is now fortunately situated with respect to electric power for pumping as well as lighting service. Recently it purchased the entire electric light system from the Northern Ontario Light and Power Co. and is now operating the system. Power is bought from the Spanish River Pulp and Paper Co.

For reservoir purposes the elevated water tank shown in Fig. 2 was constructed and is in service. The tank is 28 ft. in diameter with hemispherical bottom and has a capacity of 128,500 Imp. gal. It is 155 ft. high to the top of the tank sides and rests on 4 posts, which have a maximum section consisting of two channels 15 in. at 40 lb., and one plate 17 by $\frac{3}{4}$ in. Horizontal struts consist of two latticed channels and the diagonal bracing is of adjustable rods.

Cost.

The cost of the three filter units with all necessary accessories was \$9,000 laid down at Sturgeon Falls. The whole installation, including a new main from the pump house to the old water main on John Street, a distance of some 2300 ft. was very nearly \$80,000.

For the above information "The Canadian Engineer" is indebted to L. E. Carter, town engineer, of Sturgeon Falls, who was in charge of the work. The general contractors were McNamara Bros. and Thornton, of Sault Ste. Marie, Ont. The motors and pumps were supplied by the Canadian Blower & Forge Co., Ltd., Kitchener, Ont., and the filters by the Norwood Engineering Co. of Canada, Ltd. The elevated tank was supplied by the Canadian Des Moines Steel Co., Ltd.

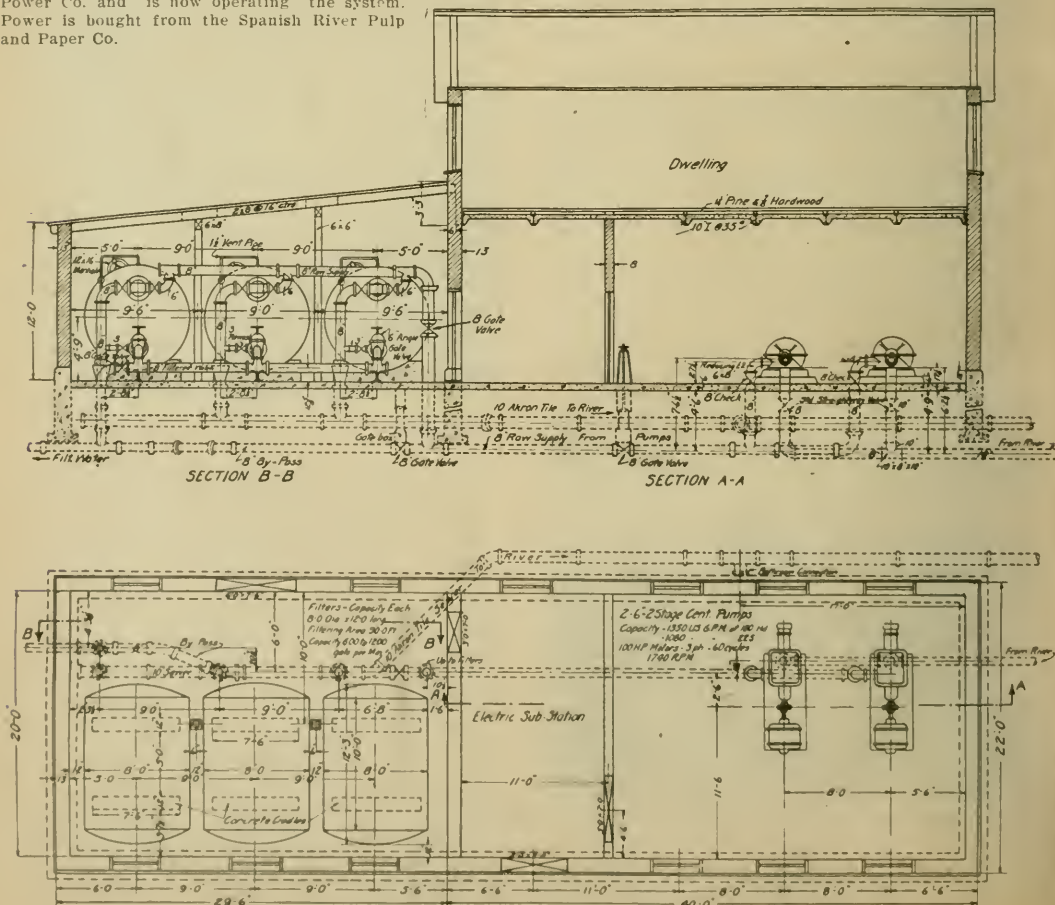


FIG. 3—LAYOUT OF EQUIPMENT IN PUMP AND FILTER HOUSE

DISCUSSION ON PAPER "PREVENTION OF SEWAGE CONTAMINATION IN ONTARIO."

DISCUSSION of F. A. Dallyn's paper on "Prevention of Sewage Contamination in Ontario" read at the meeting of the Canadian section American Water Works Association, at Brantford, and which was published in May 23 issue of "The Canadian Engineer," brought out several interesting points. Those taking part in the discussion included William Gore of Toronto, D. M. Hanna, Windsor, and Alex. Milne, St. Catharines.

The chairman, R. C. Harris, in opening the discussion, referred to the importance of the subject and hoped that the discussion would be general.

MR. GORE: Mr. Chairman, I have listened to Mr. Dallyn's paper with very great interest as an authoritative statement from Mr. Dallyn is of very great weight and importance to this Province. Of course as an official of the Government he is in a rather difficult position, but I think he has stated his case very well indeed, and I would like to congratulate him upon presenting the case in such a satisfactory manner.

There is no doubt that we all resent a certain amount of paternalism; we like to be boss in our own shanty, and to a certain extent, although supervision is necessary, we do not like supervision that is too close or that shall prevent a man deciding how he shall control his own house.

I think one of the most important points in Mr. Dallyn's remarks is that the view of the Board is that they are taking only a general view, and that they cannot come to any conclusion except in a general way. No doubt each town or each case must be dealt with on its own merits. Where sewage creates a nuisance and will not enable purification of the water supply to be carried on with any degree of satisfaction, it is very important that that sewage should be purified to a very high degree. The figure referred to in the British Royal Commission is a figure that sedimentation tanks would not carry out, that it would demand higher average purification than we have in our provinces. Our rivers, as Mr. Dallyn said, are relatively very much bigger, and therefore the amount of contamination is exceedingly important.

There is one point Mr. Dallyn referred to which I think cuts both ways, that is, the faster flow of the rivers. A rapidly flowing river purifies itself much quicker owing to its turbulence than a river which is travelling slowly. So to a certain extent a fast flowing river is an advantage.

MR. DALLYN: I was using that illustration particularly with reference to bacterial pollution.

MR. GORE: There is no doubt that the more contamination you have in a sewage supply or in a water supply the more difficult it is to treat that water, particularly in view of the alum. The difficulty is very much increased by the amount of impure material in that water. That will be shown in a later paper. It is largely I think a case of treating sewage as the result of experience. Each case must be dealt with on its merits.

MR. HANNA: Mr. Chairman, just for information I would like to ask through you this question; at what point do the Board stop in the way of acting on the initiative in the enforcing of the laws of the Province with respect to the protection of water supply? I believe from the standpoint of separation of fire lines the Board are acting independently, and I just wanted to know if there was any definite line of programme laid down in that respect?

MR. DALLYN: The question that has been asked is just a little difficult to answer. I will admit that we initiated the question of fire connection, but at the time we initiated it, the matter was under consideration by several of the municipalities, so that instead of limiting it, it was made of province-wide application. If Mr. Hanna could cite a concrete example, we might discuss it. The supervisory power, and the question when we should cease to interfere, were difficult things to deal with in generalities.

MR. MILNE: I regret very much, Mr. Chairman, that I was not in the room when Mr. Dallyn read his paper on

the control of sewage, because to a certain extent I may have been the instigator of the suggestion that such a paper be prepared.

This question has been present to my mind a great many years. On the one hand we have a water supply, and our provincial health authorities come down emphatically and say that that water must be delivered at certain sanitary plants. On the other hand, raw sewage is dumped down at the most convenient place, absolutely without regard to water conditions. The whole responsibility for water supply is being placed upon the authorities alone. I think it is unfortunate that the responsibility should be so placed. If it is compulsory and absolutely necessary to the preservation of life to supply clear, sanitary water, why deliberately, I was going to say with malice aforethought, as our legal friends would say, allow any other department to pollute that supply, thereby placing an almost impossible burden upon the water department? It strikes me that with proper administration of suitable legislation, of which we have evidence in England and in the United States, at least a partial purification of the sewage could be and should be made, relieving the water department of the entire liability for that work.

For that purpose, and not to prescribe means or to suggest legislation, or even the means of purification, my suggestion is that we open a discussion among our members and with Mr. Dallyn, who is very keen to take up anything in the way of public service, which might lead to some better solution of the situation than now exists.

MR. DALLYN: In answer to Mr. Milne's question, which is quite pertinent, I may say that I do not know of any instance of the gross pollution of a water supply by sewage in this Province, except in connection with one or two systems that were put in for fire protection solely, and not supposed to be used for any other purpose. There were one or two cases where the water was grossly polluted. Chatham has some difficult conditions with respect to variations in the river level there, but I do not know of any single instance where the pollution is of such an intense character that it would call for urgent action in respect of sewage treatment.

MR. HOWARD: Mr. Chairman. There were several points in Mr. Dallyn's paper which interested me very much, particularly at the outset, when he mentioned the powers delegated to the Provincial Board. As Mr. Dallyn stated, the policy of the Board is one which commends itself to a municipality, particularly in view of the fact that at the present time the question of sewage disposal is one of the most acute character, particularly in Eastern Canada.

Mr. Milne referred to the treatment of sewage in England and in the United States. We should bear in mind that climatic conditions in those countries are very different, so far as the treatment of sewage is concerned, to what will be found in Eastern Canada, and that the efficient treatment of sewage at the present time would involve enormous expense which, at this stage of sewage treatment, would not be justified, particularly in view of the fact that such a conservative engineer as Mr. Hazen has gone on record as favoring the dilution of sewage as a practical means of disposing of sewage, provided that the water is treated afterwards. I think that is something which commends itself to all interested in this subject. There is the question of expending enormous sums of money on sewage treatment either by filtration or aeration, with perhaps doubtful success under these climatic conditions, or the treatment of sewage with chlorine, is something worthy of serious consideration. It has been found in the City of Toronto, where the sewage discharge is between 60,000,000 and 65,000,000 gallons daily, to get an efficient effluent it would be necessary to have ten or fifteen parts of chlorine to every million gallons of sewage discharged. That would mean an expenditure of from 4 to 5 tons a day of chlorine, chlorine at the present time costing \$250 a ton; in other words, any effective treatment of sewage, putting it down at the lowest figure possible, would involve an annual expenditure of \$350,000, which represents an

enormous expenditure, and literally speaking throwing money in the lake, when we consider that with effective filtration and chlorination afterwards the citizens are supplied with water just as good or strictly comparable with the best water on the American continent.

In 1910 there was a mortality of 40.8 per thousand of population. Effective treatment has reduced that mortality to 2.9.

So that naturally sewage disposal has reached a more advanced stage, and until some better methods of practice have been worked out to a success, the policy should be to go slow and rather filter the water and treat it with chlorine than to expend large sums of money on sewage treatment.

There were one or two points in the later paper* well worthy of consideration. One was the reference to the standards of the International Board. An investigation has been going on for the past year, and from all the correspondence it would seem that the establishment of standards is impracticable. A standard that would apply in one city could not be maintained and would be absolutely impracticable in another city. In one particular city, certain standards might apply for water having a certain percentage or degree of purification, based upon certain quantities of impurities and re-agents. That has been shown all over America to be impossible at the present time; what applies to one city has absolutely no bearing upon an adjoining city, and the application of definite standards would seem to be impracticable. This particular standard the International Commission put up as to the number of B-Coli in water at the present time is an absolutely impossible one, under existing conditions.

We have heard of water supplies which contained enormous numbers in excess of those which sterilization has removed entirely.

*Paper on "Water Supply in its Relation to Sewage Disposal" by J. Clark Keith, appearing in this issue of "The Canadian Engineer."

NEW SNOW PLOW IN WINNIPEG

NOW that motor vehicles are being so extensively used, there is an ever-increasing demand for keeping the roads and streets open in winter. To meet this demand the Vulcan Iron Works, Ltd., of Winnipeg, have developed a new snow plow for attachment to any standard make of motor truck. The plow is fastened to the front end of the truck and pushes the snow to the sides of the road. It may be used either on city or country roads.

Features of this plow are its ease of operation, simple construction and the fact that it requires no attention other than that given it by the truck driver. It may be easily set up and attached to a truck by one man, no drilling of holes or other mutilation of the truck being necessary.

The plow consists essentially of the following parts: The mould board, a hinged frame connecting the plow to the truck; a raising and lowering mechanism; and clamps and brackets for attaching to the front axle.

The mould board, or blade, which is made of steel plate, is carried by a special hinged frame on the front axle, and allows the plow to be set at any angle to the

The application of chlorine was touched upon by Mr. Dallyn. I would be very much interested in knowing what the supervision consisted of, how much chlorine was considered necessary, whether there was a general standard set of figures for the applying of chlorine, and what methods were taken to see that that quantity was maintained.

MR. DALLYN: There are two questions raised by Mr. Howard that I would like to touch upon. The question of the standard of the International Joint Commission has been rather unfairly dealt with. The problem before the International was to determine what constituted an injury to health and property, and it would naturally be discussed with a view to some standard, with 500 B-Coli per 100 c.c. That arose out of what might constitute an injury to a municipality, that is, what is an excessive load to put upon a municipality if the stream had not been affected by sewage discharged by urban development.

The question of what we are requiring in the way of chlorination brings up another question. The engineers of the Board have been considering of late methods of checking up the chlorine, and we have now prepared for distribution outfits which will make it possible for plant superintendents or local officers of health to check up the chlorine.

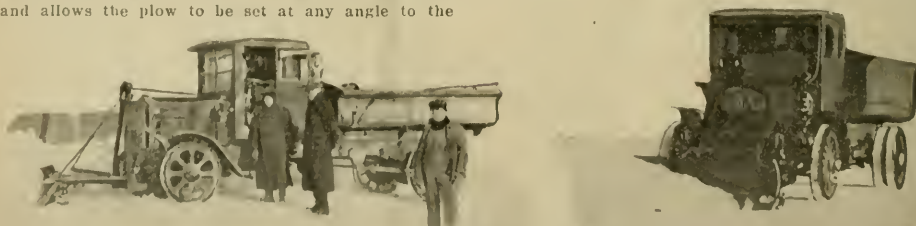
St. Catharines and other municipalities in Niagara district are to vote on bylaws soon to give the Niagara, St. Catharines & Toronto Railway extensions of franchises. In St. Catharines, Niagara Falls and other places the railway, which is owned by the Canadian Government, has been running without franchises for some time, they not having been renewed because of the negotiations looking to the Hydro taking over the road. As the proposition for the municipalities to buy the railway was voted down by a sufficient number to kill the project, it has been decided by the municipalities to give the Canadian National Railway Board an opportunity to improve the railway.

road. It also permits raising and lowering. This frame is of rigid angle-iron construction and is fastened to the front axle with specially designed steel clamps and brackets, which make it suitable for attachment to any standard make of truck. A locking worm-operated drum and cable, operated from a handle wheel in the cab, allows the plow to be raised to meet travelling conditions.

The lower part of the mould board is hinged and supported by springs which allow the plow to pass without injury over manhole tops, railroad tracks, etc. This is a great improvement over the old method of swinging the entire blade, which leaves a pile of snow in the road.

To prevent injury from contact with street curbs, rollers are attached to the sides of the blade. The plow is equipped with adjustable mushroom shoes to carry the blade slightly off the pavement if desired.

Several of these plows are now in active operation in the city of Winnipeg, where they have caused considerable interest and favorable comment among street and road officials.



TWO VIEWS OF NEW SNOW PLOW IN OPERATION LAST WINTER IN WINNIPEG.

CO-OPERATIVE ROAD IMPROVEMENT AND FUTURE POLICIES*

Remarkable Increase of Traffic — Duty of Highway Officials
— Success of Federal-Aid System — Co-operation in
Selection of Routes — Public Roads Bureau.

By Thos. H. MacDonald,
Chief, Bureau of Public Roads.

WE comprehend now as we have not understood in the past, the influence exerted upon our national life by transportation. It is the factor we find now interposed between supply and demand, between the starving thousands and food supplies, between producer and consumer. It is the factor whose absence separates, and whose presence ties together communities, States, and the nation as a whole. To supply adequate and increased transportation facilities is the motive which has influenced the American people to increase the number of motor vehicles in use since 1910 more than 1800 per cent. To provide the complement of the motor vehicle, the improved highway, is the underlying reason why the larger funds have been made available from State and Federal sources. The proper combination of these two to serve a definite purpose in the nation's economy, this is highway transportation in the making.

The widespread opposition to State programs of highway building during the years from 1910 to 1916 when motor vehicles were increasing at an unforeseen rate, the increased funds made available following the Federal Aid Act of 1916, the stagnation of actual expenditures during 1917 and 1918, the competition of industry of 1919 for materials, labor, and even more important, for rail transportation; all these have played a major part in producing the wide difference between the improved highways demanded by 9,300,000 motor vehicles and the actual new mileage constructed.

Heavy Traffic Increase.

The record for 1920 and 1921 is better, but let each State highway department make plain to the people of its State that for less than three years of the past five since large funds became available, have conditions permitted highway construction on an increasing scale. The facts which are true of construction are true also of maintenance.

The conclusions are self-evident:

1. During the period 1910-21, the potential number of motor vehicles demanding highway service increased more than 1800 per cent; our actual expenditures for construction and maintenance increased about 400 per cent.

2. During the period 1910-1918, motor vehicles increased more than 1,100 per cent, highway expenditures about 140 per cent.

3. During the period 1918-1921, motor vehicles increased about 700 per cent, and highway expenditures about 260 per cent of the 1910 figures.

But even these figures do not truly represent the differential between the demands for highway service and our actual production. Without attempting impossible refinements, if the cost index of 1918 be taken at two and that of 1910 at one, the actual increase in production of 1918 over 1910 was only 20 per cent, and if the index for 1921 is taken at 1½, the actual increase in production of 1921 is only about 233 per cent over the 1910 figure. That is, taken as a national aggregate, the number of motor vehicles, all at least potential users of the highways in some degree, has increased in eleven years since 1910 more than eighteen times. Our greatest annual production of serviceable highways measured by the construction and maintenance expenditures has been not more than two and one third times the production of 1910, and it has been only within the past three years that the production has gone forward at a rate approximating the maximum.

*Paper read at 7th annual meeting of the American Association of State Highway Officials, Omaha, Neb.

Those who are a part of these organizations have the good fortune to be engaged in their chosen field when the greatest development that can ever come is taking place. The first two or three years of something more than a decade of major road building have passed. What has gone before has been largely preparatory, a period of organization. What will come after, perhaps ten, perhaps fifteen years later, must by then be largely standardized, largely routine. The highway organizations that come after will not have such opportunities to render good, or, equally true, bad service, or be able to progress so far in a limited time in advancing highway engineering and administration, and in combining the motor vehicle and improved highways into scientific highway transportation.

The American Association of Highway Officials must awaken to the responsibility of placing before the public at large the real facts concerning highways and their relationship to highway transportation service. It must speak with authority and emphasis. It must take upon itself the serious responsibility of leadership in directing public thought and education, not by the arrogant methods of the demagogue, but by the intelligent dissemination of facts and principles founded upon knowledge and experience.

I do not wish to fall in showing my belief and enthusiasm in the possibilities and opportunities that lie ahead of the highway organizations. But I wish less to fail to place upon the conscience of each individual, regardless of the rank he holds, his responsibility. I want to see this organization accept the fact that the success of the future highway program is dependent upon the character and ideals maintained by the component forces, and that the failure of any one of these, Federal or State, reacts adversely upon the whole.

Order of Progress.

It is not possible to define for a definite period of time the exact progress made for the United States as a whole, for there is no fixed point common to all the States. Yet, from the standpoint of highway service, I list our outstanding progress for the past two years in this order.

1. The increased highway service made possible through the establishment of proper methods and the expenditure of more adequate funds for maintenance.

2. The increased highway service resulting from new construction.

3. The adoption and enforcement of better engineering standards.

4. The improvement in the administration of highways as a public utility.

Although the new construction has been very large, the mileage of highways of all types that have been brought to a serviceable condition or restored after a period of inadequate repair, is still greater. The outstanding results secured from the distribution of the large quantities of war surplus materials and equipment are found in the better and more extensive highway maintenance made possible. The Bureau of Public Roads estimates that by the end of the year, war surplus to the amount of approximately \$150,000,000 in value will have been distributed for use in highway improvement.

As of November 30 the records of the Bureau of Public Roads show that of the total allotments to the States under the two first appropriations totalling, \$266,750,000, there has been placed under agreement with the States Federal-aid funds in the sum of \$214,649,269, for 28,601 miles of highways. Of this mileage there has been completed the equivalent of 23,000 miles. You will note, therefore, that there now remains the balance of \$52,100,000 to be placed under agreement from the old appropriation.

As a foundation for the consideration of future policies under the new legislation, the Secretary of Agriculture has authorized and requested me to express clearly and without reservation his position that in the formulation of the new rules and regulations required, and in the administration of the law, the Department will request the coun-

sel of this Association through its proper committee. The Secretary is greatly impressed with the possibilities and responsibilities of the new Act, and the truly cooperative spirit which must underlie the functioning of both the State and Federal organizations to make the greatest and surest progress.

Federal Aid System.

The Act itself is remarkably comprehensive in defining and demanding a systematic plan, national in its extent, for future highway development. None of us has had, or is ever likely to have a more serious responsibility than the one imposed of selecting the Federal-aid system to be composed of the most important highways, articulating not only within the States, but with the systems of the contiguous States. Here is an opportunity to do a big, basic work, such as comes to few in the course of a life-time. The individual who fails to vision the importance of the task has no moral right to hold a position of authority in its performance. From a conception of highways as a purely local institution, a viewpoint we held for over a half century of our national life, we progressed to an acceptance of their importance to the State. This attitude persisted for another quarter of a century, until through the universal use of the motor vehicle, the transportation crises of a great war, the repeated threats of extensive railroad tie-ups, and the results already secured with Federal aid, we have, in the short period of five years, seen our more important highways extended and interconnected to form a vast network, serving local, State and national traffic, only limited by the confines of the United States. This is the conception which has been written into the law, and which, because of the projected effect of that which is done now into the future, lifts the importance of this requirement, that is, the selection of the Federal-aid system, above any other principle or duty therein announced.

There can be no doubt as to the clear intent of the law to provide for a system of roads which shall include those which are now and which after improvement are to become the major traffic lines. The different stages of improvement to which the States have progressed, and all the variations between them of topography, of population distribution, of industries, of development of natural resources, must necessarily be reflected in the laying out of the system. These details must be worked out between the States themselves and between the States and the Bureau of Public Roads. Because of these wide variations, it is only possible to suggest some of the major considerations. We do not minimize the importance of the local traffic to care for this class properly will, in general, always be the first objective of highway improvement. Our conception is rather that a choice of highways shall be made which, regardless of the order of improvement, will eventually join into a well conceived network crossing both county and State boundaries. Thus, while the immediate needs of a State or a district may determine priority of construction, each new link brings nearer the completion of the system as a whole.

Selection of Routes.

In the Western States the major lines will be largely fixed by topography, but by the same token, because long routes will be determined by single strategic points such as a mountain pass, it is the earnest hope of the bureau that the States affected will reach an agreement based on the future service that is to be rendered, not only to the local, but also to the Interstate and national traffic.

In the Eastern States, some of them with a large mileage of improved roads, it might appear that the selection of a system is not so important yet it seems to me that it is here that our greatest traffic problems lie. It will be a comparatively short time, because of new construction and better maintenance, until the trans-continental tourist will be provided with roads that are entirely serviceable throughout the seasons of the year when other conditions favor such travel. The really serious traffic problems lie around and between large centers of population. It must be re-

membered that for roads built previously many engineering details such as alignments, widths and types were planned prior to the advent of the motor traffic, and for use of the slower, lighter, horse-drawn vehicles. The considerations of weight, speed, safety, and numbers, which now must govern design, had not yet become the controlling factors. The traffic lines are from town to town, and in general follow through the most congested parts of population centers. As some of the principles which we must properly work out, the following are suggested.

1. The development of parallel lines to divide heavy traffic through thickly populated districts.
2. The development of direct, short-mileage routes, although on these routes there may now be a less amount of improved roads than on routes now followed.
3. The building of inner or outer belt lines around congested centers.
4. The reconstruction of weak sections for heavy truck traffic.
5. The widening of main routes near the largest cities or between cities where the distance is short enough to carry uniform traffic.
6. Proper connections with the routes of adjoining States.

Possibly there are many questions as to the future surfacing policies. The changes in types and specifications which will be sought from time to time by the bureau will be based upon the more accurate knowledge which is being obtained rapidly through research and through the detailed studies of the behavior of modern designs under traffic. The requirement of the 18-ft. surfacing is construed to mean that this is fixed as the minimum two-way road, where the construction is to be considered complete as first put down. This requirement will not preclude the building of a narrower pavement in those districts where the traffic does not yet justify the two-way width. I am yet to be convinced that we may not properly build now in many sparsely populated districts one-half of the final width of pavement in order to complete mileage between points, if all the other work is done to provide for the full-width construction later.

Highway Maintenance.

To insure maintenance, the strongest possible requirements have been written into the law. The Department may not slight its responsibility, and the attitude of the whole national administration demands the utmost fidelity in the continuous upkeep of the highways built. We are not left in doubt as to the meaning of the word "maintenance." The law itself states, "the term maintenance means the constant making of needed repairs to preserve a smooth surfaced highway." Further, "such State shall make provision for State funds required each year * * * for construction, reconstruction and maintenance of all Federal-aid highways * * * which funds shall be under direct control of the State Highway Department."

The bureau earnestly hopes that it will not be required to take over a single mile of highway for maintenance, but the responsibility is imposed, and this provision of the law will be enforced to the letter. It is a well established principle that proper maintenance will result only if some form of patrol is organized that places direct and continuous responsibility upon someone for the condition of each mile of road, and the bureau will not consider that the States are properly living up to the requirements of this Act until such a system is established. I do not use "patrol" in the technical sense to distinguish it from the so-called "gang" system, but rather to designate the proper combination of patrol and gang systems to meet the particular conditions of each State.

It is not necessary to touch upon all the points of the law. I have endeavored to accent the establishment of the system of Federal-aid roads as beyond all other principles, the most important written into this law. Of only slightly less importance is the requirement as to maintenance. While our thoughts may run to large construction programs, and the details of types and materials to be used,

let it be remembered that we are providing highway service, and that the degree of service rendered is determined by the lay-out of the system, and by the condition in which every mile of road within that system is maintained constantly. Every State which has established a State system of highways has found those highways almost immediately abandoned by the counties or other local subdivisions. I trust that each State in which highways are taken into the Federal-aid system, which have not up to this time been established as State highways, but have been under the jurisdiction of the local boards, will recognize this principle and make immediate plans under which all parts of the system will come under the jurisdiction and maintenance of the State without waiting for their construction.

Public Roads Bureau.

The Bureau of Public Roads will proceed under the provisions of this Act on the assumption that each State will recognize the mutual responsibilities imposed upon the State and upon the Federal organizations, and will bring its operations at once into harmony with all the provisions. Also, that each State will in fairness recognize the greater responsibilities, restrictions and requirements imposed upon the Federal bureau. The bureau does not seek initiative. It does not seek to direct the States but to co-operate with them. There is now a plan of action for the guidance of both organizations that is so clear and so explicit that neither can escape the responsibilities imposed. The Federal requirements are fairly defined and will be sincerely and faithfully enforced.

It is evident that a great misconception exists in the public mind as to the service which is being rendered by the highways. During the very long period that construction and maintenance were lagging far behind the increase in traffic, it is not to be wondered at that our highways showed a material depreciation. Through the war period, with the greatly increased use of heavy traffic units, particularly at just the seasons of the year when the road surfaces are carried on weakened subgrades, some roads did break up seriously. But this depreciation in general has not continued, and more than this, the effect of the lag in maintenance has been practically obliterated by the increased maintenance during the past three years, and by the reconstruction of the weaker sections, until our roads are in a far better condition today, than they have ever been in our history. This fact in itself controverts successfully any general accusations against our modern highways, of failure to carry the loads imposed.

The whole purpose of highway building is to make possible highway transportation, and the cost of the transportation must be reduced as low as possible. Therefore, restrictive legislation which limits too greatly the loads to be hauled on the highways should not be tolerated, as it is against a proper public policy. Legislation regulatory of the traffic on the highways should take into account that there are many factors which govern the traffic depreciation of our highways. Laws which blindly fix some maximum weight to be moved on the highways may prohibit the really profitable traffic and allow less economical and more destructive vehicles to operate practically unchecked. Both weight and speed are major factors in their destructive effect upon the highways, but the distribution of the load, the relation of the sprung and unsprung weights, the tire equipment, all have an important effect. From the research of the past two or three years, and from the practical experience of the highway organizations, we are accumulating sufficient knowledge to engage understandingly on a determination of the character of legislation which will result in a sound public policy. The solution of highway transportation lies in the proper adjustment, no less of the motor vehicle to the road than of the road to the motor vehicle. I hope to see no conflict develop between the States in the determination of traffic regulations. Such would destroy in a large measure the utility of the Federal-aid system of primary highways. Rather, because the system will for a long time be non-uniform in its carrying capacity, much

discretion should be allowed the State highway departments in determining the loads which are to operate upon specific sections of highways, and further, much discretion should be allowed the departments in the making of seasonable restrictions where climatic conditions are such that there are periods when the roads, normally fully capable of carrying heavy loads, are for a short time carried on uncertain subgrades. Here is an opportunity for the highway builder and the motor truck manufacturer to cooperate to serve the public's interest.

One other point is causing the public much concern. It is often stated that highways have gone to pieces and must be re-built. Engineers have been prompt to develop methods of improvement which are salvaging practically the full value that was originally invested in the highways. For example, some of the older macadam roads in New York State, lightly built, which are now heavy traffic lines, have been widened by concrete roadways on each side, preserving a strip of macadam, say 6 ft. wide in the centre, thus giving a 24 ft. usable surface by the addition of 18 ft. of new construction. The remainder of the macadam width is scarified and the material spread to form a better base under the new construction. This is only one example. There are so many successful operations of like reconstruction that it may be taken as a principle that if roads are well maintained they may be reconstructed, when traffic becomes so heavy as to require it, in such a way as to preserve the major part of the investment and build it into the new highway as an integral part. It is my judgment that our heaviest traffic lines of the future will be developed in this manner, for we must recognize the principle that at the present time the big task is to get a mileage of surfaces that can be maintained under the traffic. Perhaps the principle that we should remember it to do the fundamental work right. Road surfaces are built for use and we must expect them to wear out. The one thing that we must do is to furnish highway service, for this is an essential factor of highway transportation, and we must rely on highway transportation to pay the major portion of the costs of the whole construction and maintenance program ahead.

TESTS ON CONCRETE PIERS

ACCURATE data on the sustaining power of cylindrical concrete foundation piers and the underlying stratum on which they rest has been obtained by means of experiments which have been conducted in the United States. Two test piers were constructed. Each pier was 4 ft. in diameter. One of the piers had a belled base to furnish a bearing surface 8 ft. 4 in. in diameter. The other pier was a plain cylinder. Concrete for the major portion of the test piers was of 1 : 2 : 4 mix. A richer mixture, 1 : 1 : 2, was used for the upper 4 ft. 4 in. Fine aggregate was sand and coarse aggregate was 1 in. crushed limestone. The upper portion of each pier was reinforced with eight $\frac{1}{2}$ in. round steel bars 6 ft. long, placed vertically in a circle 2 $\frac{1}{2}$ in. from the outer surface of the pier. Outside of these vertical bars, thirteen $\frac{1}{2}$ in. hoop bars with 24 in. laps were placed horizontally on 4 in. centres. Hoop bars reinforced the piers from 2 in. below the upper surfaces of the piers to a depth of 4 ft. 2 in. A load of 340 tons, equivalent to about 6 $\frac{1}{2}$ tons per square foot, of bearing surface was applied and allowed to remain for forty-eight hours. The total deflection was 3/16 in. The load was finally increased to 970 tons, or about 18 tons per sq. ft. of bearing surface. The load remained on the pier for eight days and the total deflection was 1 $\frac{1}{2}$ in.

The Edmonton Automobile and Good Roads Association has secured the services of P. A. Parrish to organize sections of the Association in all the rural towns tributary to Edmonton. The Association has also engaged an engineer, S. E. Reaugh, to make a survey of the proposed Jasper highway.

FIRE PREVENTION A PATRIOTIC DUTY*

By Harold S. Weldon,
Canadian Inspection and Testing Co., Ltd.

DURING the year 1921 the fire loss of Ontario, as determined by the Fire Marshal, was \$15,444,817, an increase of nearly four million dollars over the year 1920. The number of fires was 9813, an increase of 517. Over one million dollars a month is the loss to Ontario of property, due chiefly to our carelessness, and during this year the number of fires should have shown a decrease, rather than an increase. For the year 1922 what are we prepared to do to help stop this wanton destruction of life and property, 80% of which is preventable?

Too few people realize that Canada's fire waste is stupendous, and is, in fact, the largest per capita of any country in the world. Thus it is very plain that the facts concerning the prodigal dissipation of our national wealth cannot be too frequently or too forcefully presented for public consideration and analysis. This direct loss of millions can be prevented, and the money thus saved used to build up the resources and assets of our country; for when any factory, store or any of the nation's assets are burned, the nation's life and vitality are weakened, since its citizens are thrown out of employment, and the circulation of large sums of money, through the weekly pay roll, ceases.

Every citizen should, therefore, support every possible remedial measure that will reduce the destructive results of fire, and incidentally, the price we shall have to pay for permitting carelessness and difference to sap our resources! This may be brought about by:

(1) Suggesting a better measure of community planning, with proper restraint of the use of property, and the efficient co-relation of all elements of the community in order to reduce the fire hazard.

(2) Insisting on sufficient community protection, if not already provided, consisting of an adequate water supply, and a fire fighting organization.

(3) Urging a better type of building construction, that will provide against danger to life, in case of fire, such construction to include proper mechanical aids for the discovery and extinction of fire.

(4) Advocating a type of construction, that will prevent the spread of fire beyond the buildings in which it originated.

Thus fire prevention involves the construction and maintenance of buildings so that the danger of fire may be minimized. The precautions which should be taken, may perhaps be dealt with best, by considering the subject under a number of headings.

Manufacturing Section.

Factories and industrial plants are responsible for approximately 50% of the total annual loss. Each industry carries with it, its own special fire hazards, and each employer should see that his property is well equipped with fire fighting appliances, and that his employees are acquainted with their use. He should also impress upon his employees the necessity of observing proper precautions to prevent fires, and also that a fire may mean that they may be thrown out of employment. In any plant a watchman should be employed at all times when it is not in operation. There should be some mechanical device installed at different points of the plant, which will record the time of each of his visits, and he should be thoroughly acquainted with the system of fire protection, and know how to use it.

All shafting or machines equipped with belts should be grounded to prevent sparks which may be caused by static electricity. All oily waste should be put into recep-

tacles with self closing lids, and the contents from these metal cans burned daily.

Cleanliness is one of the most important factors in any plant for the prevention of fires. If in the shipping and receiving rooms, all waste is gathered regularly and burned or stored in tin lined boxes, and all boxes of supplies piled in tiers, and spaced, to permit of easy access, and inspection, much will have been accomplished.

In factories where dust is prevalent because of the commodity manufactured, such as flour, sugar and starch, or where dust may be caused, as when coal or grain is handled, the greatest precautions must be taken to prevent this dust, either from settling out on beams, etc., or from passing out into the rooms where it is then entirely surrounded by air, thus promoting rapid burning. It has been found that this is the most inflammable part of the dust, and if mill operators would realize that this dust may be ignited as easily as some gases, and that under proper conditions an explosion may propagate through it as rapidly, and with as great force as the explosion of certain gaseous mixtures, it is probable that greater precautions would be taken.

While no explosions have been known to have been started by the ignition of dust settling on a carbon filament lamp, nevertheless the breaking of almost any type of electric lamp bulb in a dusty atmosphere may cause an explosion. A match will ignite almost any inflammable dust, including a cloud of aluminum dust.

If we are to prevent explosions, everything possible should be done, both to remove the sources of ignition, and control the dust wherever possible. Open flames of all kinds should be prohibited; carbon lamps should not be used; all lamps should be protected with vapor globes, and with heavy wire guards; all electric switches should be enclosed and every possible precaution should be taken to prevent friction with consequent development of heat or sparks.

The manner in which dust may most successfully be removed, is by installing a suction plant, which will draw off to a closed container, designed for the purpose, all dusts which can be easily collected, such as in grain elevators, where there is a throw of grain.

The installation of an automatic sprinkler system cannot be too strongly stressed, such system to be periodically inspected and tested.

In order that fire cannot spread from one floor of a building to another, fire proof stairways and elevator shafts will give the most efficient protection, and fire walls with fire doors properly installed, will prevent a conflagration from spreading to adjacent departments when situated on the same floor.

Fire Prevention In the Home.

Two out of every three fires occur in our homes. It is yesterday's dirt that always starts the fire. The element of carelessness probably has less check in the home than elsewhere, as is witnessed by the many and varied causes of fires in the home. Old clothing and useless articles stowed away in the cellar or attic; defective chimneys; matches being carelessly placed in improper places, or where children may reach them, placing ashes in wooden receptacles, and the careless use and handling of coal oil, whether in lighting a fire, filling lamps at night, or leaving lighted lanterns in dangerous places. These are only some of the causes of many families being left homeless.

Special care should be taken to prevent fires starting in the home, because before outside help arrives, serious damage is usually done.

At the present time there is a world wide housing shortage, and the present wastage of homes per year, due to fires, is one quarter of the total number built, in the corresponding twelve months. The day when there will be surplus homes would arrive much sooner if this wastage could be eliminated.

The protection of forests from fires, is today one of the great problems of our country, especially in those reg-

*A winning essay in the recent competition conducted in the Faculty of Applied Science, University of Toronto, for prizes offered by the Fire Marshal of Ontario.

ions where there is the virgin forest, with years of accumulated debris. The advent of the railways, with the subsequent lumber, tie and pulp operators, also create a very serious hazard.

More than four times as many people are burned to death in Canada as are killed on steam or electric railways. Thousands of acres of good timber lands are burned in each year because of the carelessness of settlers and tourists.

Each year the government appoints a large staff of fire rangers, whose duty it is to detect and fight fire, but despite this large staff, each year much good timber is lost. It is estimated that over 50% of forest fires are caused by campers, railways, incendiarism, bush burning and lumbering.

The most effective way to prevent these fires is by each one realizing his own personal duty and refrain from carelessly lighting and leaving fires, or dropping a lighted match.

Fire Stopping in Frame Buildings.

The importance of fire stopping, in frame constructed buildings, for the purpose of retarding the progress of the fire, after its origin is, indeed, well established, and especially applies to the countries where construction is more or less temporary, and is of frame character. In buildings the greater proportion of fires, are of interior origin, and therefore some method of fire stopping is essential.

The principle to be applied in fire stopping in frame construction is that of closing up all vertical openings between studs, and all horizontal openings between joints, thus preventing the rapid circulation of fire by draft through the frame after the fire has been started. Fire stopping, preferably by the use of incombustible material, laid in between studs, to a height of from 4 to 6 in. will tend to confine a fire to a cellar or basement, and prevent its rapid spread to stories above, through spaces between the studs. It will also prevent fires starting in the attic, from spreading to the floor below, because of sparks falling down through the openings between studs.

Precautions in Using Electricity.

Before any building, factory or barn is wired, a permit must be obtained from the Hydro-Electric Power Commission, and it is necessary that only skilled electricians be employed.

In interior wiring, the most common cause of fires are poorly designed fittings, poor workmanship, carelessness, improper materials, and the misuse of materials, designed for a certain service. Flexible cord, designed for pendant use only, is a material much abused, and has been the cause of much trouble.

The over fusing of circuits offers a very serious fire hazard, and is very often due to the so-called "handy man". This is a punishable offence, as fuse holders must not be filled with other than approved fuses of a proper carrying capacity, or must not be bridged with wire, or other objectionable material. All fuse blocks and knife switches should be enclosed in steel boxes, especially when exposed to inflammable material, or when there is any chance of personal contact.

Special attention should be given to seeing that heaters, small motors, etc., are not connected to the ordinary lamp sockets, and for these appliances special wiring should be installed, sufficiently heavy, to carry these loads.

As in the case of the prevention of accidents, the personal factor is of very great importance in the prevention of electrical fires, and it is only by gaining a knowledge of how to use these devices correctly, and then being careful to use them always in this way, that loss of life and property may be prevented.

Fire Prevention by Lightning Rods.

From records kept by insurance companies, lightning rods have proven to be from 95% to 100% efficient, or in other words where 100 buildings have been properly equipped with lightning rods, less than 5% of the buildings were struck with lightning, and it is very probable that in these few cases, their installation and maintenance was

faulty. Copper rods are the most serviceable and the maintenance costs in time and money are very small. All machinery, etc., in buildings, should be grounded, as should silos and metallic roofs. All rods should be grounded 10 ft. deep in earth, which is always moist, or provision should be made to keep the ground moist.

It is the duty of every good citizen to join the great army of fire preventionists. Perhaps the most important manner in which each can do his share, is to appreciate his personal responsibility in connection with the prevention of, and protection from, fires.

PEACE HIGHWAY PROJECTED.

CANADA, the United States and Mexico are now being linked together by an international trunk line connecting Quebec with Mexico City and running northeast and southwest through some of the greatest industrial cities of the United States. It is known as the International Peace Highway.

Almost the entire 2,700 miles from Quebec to Mexico City have been practically decided upon. Two debatable routes through a part of the mid-west are all that now remain to be settled upon. By June or July, the Peace Highway will be marked out by automobile clubs in all the States through which it passes.

These markers are themselves a bit of sentiment that cannot fail to arouse good feeling as well as patriotic fervor in both Latin and English-speaking nations. Triangular in shape, a white field is enclosed by edges of red, green and blue, combining the colors of the three nations. Those of Canada and the United States red, white and blue, are thus blended with the red, blue and green of Mexico.

Route of the Highway.

The road will run through the following cities: Quebec, Three Rivers, Montreal, St. Johns (Canada), Rouse's Point (N.Y.), Ogdensburg, Clayton, Watertown, Oswego, Rochester, Buffalo, Erie, Cleveland, Columbus, Cincinnati, Frankfort, Lexington, Louisville, Henderson, Paducah, Cairo, across the Mississippi on a bridge which will join Kentucky, Illinois and Missouri, Poplar Bluff (Mo.).

Between Poplar Bluff and Dallas alternative routes have been suggested. The first is from Poplar Bluff to Springfield, Mo., through Joplin, Muskogee, Okla., on to Dallas. The second goes to Dallas by way of Little Rock, Hot Springs and Texarkana.

From Dallas southward the highway runs through Waco, Austin, San Antonio and Laredo, Texas, across the state of Nuevo Leon to Monterey, to Saltillo and then through San Luis Potosi, Dolores, Queretaro and Tula, to Mexico City.

UNCERTAIN ASPECT OF ST. LAWRENCE SCHEME.

WHETHER further steps will be taken to negotiate with Canada regarding the Great Lakes-St. Lawrence waterway project has not yet been determined by the Washington Government.

Canada's reply to the first American proposition, suggesting that the time is inopportune to open such a question, has brought the discussion momentarily to a standstill. State department officials say, however, that they had not yet carefully examined the Canadian note and were uncertain whether it closed the door to further exchanges.

In some quarters, in Washington, the impression prevails that a way will be found to create a commission to inquire into the feasibility of such a waterway.

Reports from St. John, N.B., indicate that the New Brunswick Power Co., contemplates making extensive improvements to the plant. The firm of Sanderson & Porter of New York will direct the management and operations of the company under the immediate supervision of the new manager, M. A. Pooler.

WATER SUPPLY IN ITS RELATION TO SEWAGE DISPOSAL*

Pollution of Detroit River — Remedial Measures Suggested
— Reference to International Joint Commission's
Report — Sewerage System Constructed.

By J. Clark Keith,

Chief Engineer, Essex Border Utilities Commission.

THERE exists along the Canadian side of the Detroit River in Essex County, a peculiar situation, without parallel in Canada. Eight municipalities with adjoining boundaries front on the river over a distance approximately ten miles, each with its own municipal government but all on the same drainage basin and each vitally concerned in its sanitation in relation to its upstream neighbor. There are no outstanding topographical features in any portion of the district, it is universally flat, the difference between contours being about 25 ft. With this condition existing the problem of drainage is an acute one inasmuch as it all must have its outlet in the Detroit River which is the source of the district's water supply.

International Joint Commission's Standard.

In the final report of the International Joint Commission in 1918, a board of advisory engineers from United States and Canada, among whom was the provincial sanitary engineer of Ontario, made a resume of testimony which was submitted to them which has a direct bearing on this subject and from which some excerpts are given. "In waterways where some pollution is inevitable and where the ratio of the volume of water to the volume of sewage is so large that no local nuisance can result, it is our judgment that the method of sewage disposal by dilution represents a natural resource and that the utilization of this resource is justifiable for economic reasons provided that an unreasonable "burden or responsibility" is not placed upon any water purification plant and that no menace to the public health is occasioned thereby.

Much discussion centered on what was implied in the phrase "burden or responsibility" and the advisory board stated that the safe loading of a purification plant was exceeded if the average number of B. Coli exceeded 500 per 100 c.c. or if in 1/10 c.c. B. Coli is found 50% of the time.

In view of the progress which is being made at the present time in sanitary science, this limit or standard should be regarded as tentative. This is probably a very conservative limit as a filter plant has been constructed on the island of Bob-lo almost at the mouth of Detroit River and from which excellent results are being obtained.

It was further stated that "in general, protection of public water supplies is more economically secured by water purification at the intake than by sewage purification at the sewage outlet but that under some conditions, both water purification and sewage treatment may be necessary."

There will probably be general acceptance of the latter finding as a temporary interruption in sewage treatment or contamination from an obscure source or a single individual might at any time endanger the health of an entire community if entire reliance is placed on sewage treatment alone.

Alternative Methods.

Sewage disposal may bear a varying relation to water supply in their relative treatment.

(1) A filtered water supply in conjunction with sewage disposal in accord with the more approved present day methods.

(2) The water supply unfiltered but with effective sewage treatment.

(3) The water supply unfiltered with sewage treat-

ment which will prevent nuisances and protect fish life. The absolute merits of any remedial measures must in almost every case be considered from the economical aspect as well, a compromise between the two may generally be effected and be acceptable. In Great Britain and Germany practically all surface waters are filtered and if this principle were adopted in Ontario, then sewage treatment to the extent of removing nuisances might be considered effective.

The most serious pollution of any of the boundary waters is found in the Detroit and Niagara Rivers. This pollution has its origin chiefly in the sewage and storm flows from the riparian cities and towns and the sewage from vessels. Extensive analyses were made by the International Joint Commission in 1913 and the B. Coli count varied from 5 per 100 c.c. at the head of the Detroit River to 10,592 per 100 c.c. at Amherstburg. In 1920 a further series of analyses were made by the Provincial Board of Health as a guide to a board of engineers reporting on a water supply for the Essex Border District and there was an average increase in pollution of 50% in that interval notwithstanding extensive improvements in the sewage systems of the District.

Morris Knowles' Report

The border municipalities realizing that independent action in regard to their sewage problem as affecting their water supplies would be fruitless of concrete results, co-ordinated their activities by the formation of the Essex Border Utilities Commission in 1916. The town of Ford, upstream from Walkerville and Windsor was without any adequate system of sewers and approval of piecemeal construction was withheld by the Provincial Board of Health. This condition could not be prolonged indefinitely and in 1917 an extensive report was made to the Essex Border Utilities Commission by Morris Knowles dealing with the related questions of sewage disposal and water supply. It was recommended (1) that an intercepting sewer be constructed from Pelee Road in Ford City along Sandwich St. through Ford City and Walkerville to an outlet in the Parent Ave. sewer in Windsor. (2) that an intercepting sewer be constructed from 14th Street in Ojibway, following Main St., Sandwich St., and Russel St. with its outlet at Park St. in Sandwich.

Sewerage System.

These two questions were submitted to the ratepayers of Ford, Walkerville, Windsor, Sandwich, Sandwich West and Ojibway and their construction was favored by a vote of 7 to 1. The cost was apportioned among them, taking into consideration area, population, assessment and "capacity times distance" as bases. As an economic factor the interceptors were designed for sanitary flow only with storm overflows into the river. These overflows are regulated by means of positive action floats and sliding gates to admit to the interceptors at all times an amount equivalent to the dry weather flow of the district. Owing to the small available slope, it was necessary to construct a sewage pumping station at Walkerville which would lift the sewage from these two municipalities about 18 ft. to a sewer continuing along Sandwich St. to the Parent Ave. outlet. The operating cost of this station is borne by these two municipalities in direct proportion to the amount of sewage they contribute to it, records being available through venturi meters at their boundaries. The eastern section together with the Walkerville pumping station was completed in February, 1920. The southern section was completed in May, 1921, and as a result five miles of the river front were freed from sewage pollution, nine objectionable sewage outlets were eliminated and all the sewage from the towns of Ford and Walkerville enters the river below the intakes of the Walkerville Water Co. and the city of Windsor. The quantity of sewage so diverted amounts to about 2 1/4 millions gallons per day or is equivalent annually to the total flow of the Detroit River for ten minutes. Eventually the sewer will be constructed across Windsor to a disposal plant in Sandwich. When the International Joint

*Paper read at the annual meeting of the Canadian section American Water Works Association, Brantford, Ont., May 12-13, 1922.

Commission issues the ultimatum that the pollution of boundary waters must cease, the Essex Border District will have the work well under way.

Proposed Filtration Plant.

While the construction of these sewers was in progress, there was a periodic demand for filtration due to seasonal disturbances in the water supply. Within the past five years plans for filtration plants have been prepared for both the Walkerville Water Co. and the Windsor Water Commission. Neither of these water organizations had taken any action as there was at the same time a feeling in the district that a joint plant might be constructed which would effect economies for all concerned.

Reports on joint schemes were submitted in 1917 and 1919 but they did not offer a satisfactory solution to all interested parties. In 1920 a joint board consisting of F. W. Thorold representing the town of Walkerville, E. M. Proctor the city of Windsor, and Morris Knowles the Essex Border Utilities Commission, brought in an unanimous report which they recommended from the viewpoint of economy and of the future growth of the district.

The recommendations in brief were that an intake, low lift pumping station and filtration plant be constructed at Strabane Ave. in Ford City and that filtered water be supplied through a gravity main to the pumps of the Walkerville Water Co., and the Windsor waterworks. These pumping stations would distribute water as they are now doing for the next thirty years when an existing water franchise expires or until amalgamation of the Border Cities became an accomplished fact.

As a result of a recent conference, the question of the construction of this plant will be submitted to the electors in December next.

Notwithstanding the elimination of the sewerage from the river front above the present intakes in Windsor and Walkerville, there is a growing increase in pollution. At the outlet of the Parent Ave. sewer there was an average bacterial count of 10,650 B. Coli per 100 c.c. in 1920, a figure which could only be obtained much lower down the river in 1913. This same condition is no doubt apparent not only in boundary but inland waters as well and the one safeguard for the health of this province would appear to be in strict provincial or international control, resulting in adequate treatment both of water supply and its complement, domestic wastes.

WILL SURVEY FORT WILLIAM AND DISTRICT

ACTING under instructions from the topographical division of the Dominion geological survey, E. E. Freeland, topographical engineer, will carry out a topographical survey of the two cities of Port Arthur and Fort William and the surrounding district, including an area of about 250 square miles of land, not including the area covered with water.

The district to be covered by this survey will run north to include Bare Point and Wild Goose Island, the western line will include Murillo, the south line will run through the center of Loch Lomond and the eastern boundary will include Silver Islet.

The maps which will be made, following this survey, will show the elevations and contour lines, streams, lakes, marshes, roads, buildings, bridges and railways, while the portion of the maps including the cities will indicate railway yards, with the tracks, as far as possible, the business section and thickly built-up residential sections will be conventionalized, while the houses on the more scattered sections will be indicated separately. Incorporated in this map will be a map of a portion of Thunder Cape, made two years ago by Mr. Bartlett, of the geological survey.

By conventional signs the good roads and poorer roads will be distinguished, which will make the map very valuable for autoists and tourists. The original scale of the maps prepared by Mr. Freeland will be 3,000 ft. to the inch, but in the completed map, as published, this scale will be reduced to one mile to the inch.

SCHOOL OF ENGINEERING RESEARCH, UNIVERSITY OF TORONTO*

By Maitland C. Boswell,

Associate Professor of Organic Chemistry, University of Toronto.

UPON the recommendation of the late Dean Ellis the School of Engineering Research of the Faculty of Applied Science and Engineering of the University of Toronto was established in the spring of 1917. It is under the direct supervision of a committee of management composed of fifteen members of the faculty council. To this committee is entrusted the selection of researches to be undertaken, from among those proposed by members of the staff, and the disposition of funds for conducting them.

The School was organized chiefly for the training of graduates in the methods of research, and for the carrying out of investigations. These latter may be problems relating to specific industries or raw materials and having a specific end in view, or they may be general problems having to do fundamental principles. A number of research assistants are appointed annually in the various departments of the faculty to carry on the work of research, under the direction of members of the staff. The facilities of the School are also open to other graduates, who may wish, either to obtain more experience in research, or to carry on investigations arising out of their own work since graduation.

A modest request for funds for the salaries of research assistants, and for the purchase of apparatus and supplies necessary for several specific investigations, having met with an encouraging response from the President and the Board of Governors of the University, the first research work, carried out under the auspices of the School, commenced at the opening of the session, 1917-18.

Success Attained.

The success of the School at the outset was somewhat greater than usually attends a research movement in the first year of its organization. Although papers containing the results of the investigations constitute only one means which the success of a research movement may be estimated, yet this is an important criterion of its growth. Bulletin No. 1, with fourteen papers, containing the results of investigations in six departments of the faculty, appeared in the autumn of 1919, and was very favorably commented upon by numerous engineers, investigators, and scientific and educational bodies, among whom it was given a wide circulation. The establishing of the School was justified, and those actively engaged in its work were encouraged to still further expand its activities. Further researches were undertaken, requiring a greater number of research assistants, and more apparatus, the increased expenditures being generously met by larger appropriations by the Board of Governors. Bulletin No. 2, containing seventeen papers, has just appeared, and will be followed during the coming summer by Bulletin No. 3. The very favorable reviews of the papers of Bulletin No. 2, which have already appeared in the scientific journals, as well as the increasing number of requests for papers and bulletins, are very encouraging indications of the steady progress of the School. So great was this demand for separate papers from engineers and investigators in many parts of the world, that the editorial committee decided to publish subsequent bulletins in sections, each section containing a paper or group of papers dealing with a single problem or group of related problems, the main bulletin consisting of several of these sections bound together in a single volume.

Research Spirit.

However, it is not in the publication of papers alone that the effects of a University research movement are felt. Of equal importance is its influence upon the undergradu-

*From Transactions, University of Toronto Engineering Society.

ate. Contact with a larger number of graduate students and members of the staff, who are carrying on research work, will more quickly develop the desirable point of view of the investigator, who reads the current literature of his science, and the original sources of information, rather than text books, which often have a tone of finality, and thus tend to leave the impression of science as a finished product, instead of as an organism undergoing constant change and growth. Thus, the undergraduate will be induced to develop his knowledge of the principles and laboratory technique of his science, so that he also may play a part, either in extending the bounds of knowledge, or in assisting in its applications to industry. The importance of this reaction of the School of Engineering Research upon and undergraduate, which will be more and more apparent as the School develops, can scarcely be overestimated. It is just this investigating quality which characterizes a university, and distinguishes it from a high school. A university is not a hopper through which huge masses of pre-digested facts are poured into students' heads.

This research movement has had a very encouraging and promising beginning. It has met with a considerably greater measure of success than is usual with new research organizations. That it may continue to grow, until it comes to occupy a position in the life of the university and the State, comparable with that attained by the long established and justly celebrated laboratories of older countries, should be the earnest desire of all the students, graduates, staff and friends of The Faculty of Applied Science.

INSPECTION OF STRUCTURAL STEEL*

INSPECTION as ordinarily provided for in specifications is a form of insurance. Its object is to ensure the performance of the specifications in all details so that the purchaser will receive that which the manufacturer contracted to deliver.

The inspection of structural steel with which this article is specially concerned may be classified into the inspection of: (a) Materials; (b) Workmanship; (c) Dimensions; (d) Erection.

Inspection of Materials.

Inspection of materials covers all the processes of manufacture as well as inspection of the finished product. In all but exceptional cases it is sufficient in the inspection of steel for structural purposes to confine the inspection of the material to an examination of the finished product. This includes testing samples of the steel to determine if the chemical and physical properties are correct. In the surface examination of the steel defects such as slivers, cracks and blisters are noted and where they are of a serious nature, they are cause for the rejection of the pieces in which they occur.

Rusted surfaces are also examined and the Inspector has to distinguish between surface rust, which can be removed with a wire brush, and pitting which is more serious, and which is usually a cause for discarding the material.

Inspection of Workmanship.

Under this heading come the various operations carried out in the shop, the most important of which are shearing, punching, reaming, fitting and riveting. It is the duty of the Inspector to see that these are properly carried out without damage to the steel and in accordance with the specifications.

There are some points about which the Inspector has to be particularly alert. In shearing, care should be taken to see that the distance from the centre of rivet holes to the edge of the plate is not less than the minimum distance required by the specifications. In punching, the centering of rivet holes should be watched. In reaming, care should be taken to see that the drills are inserted at right angles

to the axis of the member being drilled. In fitting, all burrs should be removed from the edge of the rivet holes and the pieces drawn together and bolted tightly with sufficient bolts to keep them in close contact while they are being riveted.

Careful attention should be given to the matching of the holes when two or more pieces are to be riveted together. If the matching of the holes is not good, it may be corrected, where the conditions will allow, by reaming the holes to a larger diameter and using a rivet of corresponding size.

In riveting, the inspector must see that the rivets are tight and have properly formed concentric heads. Strict attention should be given to the dies and all worn dies should be discarded. Close watch should be kept on the compressor gauge to see that sufficient pressure is being supplied to the riveting machines.

There are other operations, perhaps not quite so important as those we have already mentioned, to which attention must be given. Among them are chipping, counter-sinking, grinding and milling.

Dimensions.

The inspector is not only responsible for workmanship but it is his duty to see that the fabricated pieces conform to the drawings in every detail. The sizes of the sections composing the member, the overall length, the spacing of the rivets and other dimensions have to be checked up. Particular attention is paid to the open holes for field connections and to all governing dimensions such as the height of brackets on columns and the distance from the end of a beam to the point where other beams frame in. In structural steel designing, certain combinations of members occur frequently and the designs of these are usually standardized. These standards are different for various shops and thus it becomes necessary for an inspector to familiarize himself with the practice of each shop. Standards are usually available in blue print form from the drawing office.

Erection.

The field inspector takes the fabricated steel and sees that it is erected to form the structure desired. Inspection of the assembly of the parts and the riveting, painting and other operations are part of his duties.

General Duties.

The inspector has other duties arising directly out of his position as representative of the purchaser. He is usually required to follow the progress of the work and to assist in getting the different parts of the work in the order required in the field. He has also to keep track of all extras on the contract and to check the weight of all fabricated material purchased on a pound price basis. He has also to make progress reports on the job from week to week to his principals.

The Commission maintains an inspection staff in the laboratories department which is charged with the duty of inspection as outlined above. During last year this department inspected upwards of 11,000 tons of structural steel made up into buildings, bridges, transmission towers, penstocks and tanks.

Announcement is made of the appointment of the Canadian Fairbanks-Morse Co., Ltd., Montreal and Toronto, as sole Canadian agents for the Austin Manufacturing Co's line of road-making and maintenance machinery. The Austin line includes: motor road rollers, steam road rollers, motor sweepers, street sweepers, street sprinklers, road oilers, road scarifiers, rock crushers, elevating graders, and reversible graders.

The Peterborough branch of the Engineering Institute of Canada and members of the Peterborough Utilities Commission paid a visit recently to the power plant at Raney Falls, which was built by the Hydro-Electric Power Commission of Ontario. The plant, which will be in operation some time this summer, will have a capacity of 10,000 h.p.

*From the Bulletin of the Hydro-Electric Power Commission of Ontario.

ARTISTIC DESIGN OF BRIDGES*

By Charles Evan Fowler

Chief Engineer, Detroit-Windsor Bridge; Consulting Engineer.

USE of the term "Architecture of Bridges," which is common enough, would seem to the writer to point to a misconception of the real problem. There is as yet no architecture of bridges and it is doubtful if there ever will be any system of hard and fast rules to govern their artistic design. There are, however, certain fundamental principles and certain elements of design which must be observed, if we are to arrive at a pleasing ensemble for any particular structure. The problem is much more simple if we are designing a stone arch bridge, or one of concrete, or one of reinforced concrete, than is the case when designing a steel span or series of such spans. However, there are certain basic principles that apply to any and every type of bridge.

Artistic Essentials.

Simplicity, Harmony, Symmetry and Proportion must be regarded in any design that would have any pretensions to beauty or artistic effect. They are the fundamentals of true architecture or artistic design, no matter what the structure may be to which thought is to be applied in its design.

Simplicity means first a truth-telling structure, no subterfuges about the lines of stress, no covering of a concrete structure with a stone facing, no frivolous or inappropriate details, but a strict adherence to the necessary features, whether they are to carry the loads or to ornament the bridge.

Harmony is essential to a pleasing or artistic design, for without it the structure would be distasteful. Harmony not only as between substructure and the superstructure; between the various spans; between the spans and approaches; between the utilitarian features and the ornamental details, but with the surroundings as well.

Symmetry may or may not be essential to a pleasing design, although it usually is necessary if a truly artistic structure is to result. Where the bridge has great length, unsymmetrical features are not so noticeable as in a shorter one, which may all be seen at a glance. As is often true in a landscape, balance must often be secured by including an unsymmetrical feature. That is, wherein one portion of a structure, a draw span or other unbalanced feature must be included that will destroy the symmetry, something must be introduced in another portion that will restore the balance, although symmetry does not result.

Proportion is necessary, that the three preceding principles may be realized, and usually, but not always, when the economical proportions have been determined, they are pleasing. However, in many cases modifications must be made to reach the point where economy and beauty can both be satisfied. Proportion of the details employed for ornamentation is quite another thing, and to be harmonious they must also be properly proportioned.

Examples may be seen in almost every structure of the proper application of some of these principles, but more often do we find most of them flagrantly violated. The remark made by C. Shaler Smith, the dean of American bridge engineers, to one of his assistants—"Most bridges are examples of what not to do"—must be remembered by anyone who wishes to attain to high rank in his profession. It is to be feared that in most cases we feel that, "in the long run, the average sense of the many is better for the many than the best sense of any one man." There is a right and a wrong; most engineers attain neither, in the hope they are right and the fear they are wrong.

Pleasing Ensemble Vital.

We need not care whether a detail is Byzantine, Greek, Roman, Gothic, or Renaissance if it is of the proper proportion,

portion, harmonizes with the other details, with the structure, and helps in forming an entirely pleasing ensemble. The Gothic arch was Persian before it was Gothic. Our structure may be similar to a work of architecture, in that it is neo-classic, but who would say that for this reason the Rathaus of Cologne, or the Hotel de Ville in Antwerp, are not good pieces of art?

The diagonals or latticing in a bridge are sometimes unpleasing, and at other times in some other structure, not unpleasing. They probably originated with the savage, who used vines or fibre to form diagonals for his primitive structures. The farmer of today still uses ropes or wire for similar purposes, but as yet diagonal bridge members, nor yet the garden trellis, have been accorded a niche among architectural styles. The engineer, for some scores of years, has calculated his diagonals, and used them in his design because he believed they were necessary, no matter how incongruous they appeared. Now we know how to provide for secondary stresses and can often omit the diagonals whenever a more pleasing structure will result.

Ornamentation.

The curved lines of the suspension bridge and of the arch are inherently beautiful, and simplicity is best illustrated in its pleasantest features in bridges of this type with no decorations or embellishments of any kind. However, we must not overlook the fact that even a chaste design may be much improved in appearance by the use or addition of appropriate and harmonious details or decorations. The suspension bridge seems sadly designed where the towers are not properly completed by a parapet or attic storey for those of stone, and perhaps crestings for those of steel. The arch is made more beautiful by molded work in the arch ring, by the use of appropriate medallions at the key stone, by the careful embellishment of the spandrels or spandrel arches, and lastly by the use of well designed and ornamental parapets and parapet railings.

Harmony is best exhibited where no part of a structure or of its decorations seem to be extraneous, and where the structure harmonizes with its surroundings. This latter feature is illustrated by the harmony of the battlemented towers of the Conway suspension bridge and the Conway tubular bridge, with Conway castle; by the harmony of the medieval towers of the London Tower Bridge with the Tower of London; and by the harmony of the stone towers of the old Brooklyn bridge with the high buildings of New York City, although this is but a happy accident, as the buildings were the later development.

Symmetry.

Symmetry in its simplest form is where one-half of the structure is exactly like the other half, where one approach is like the one at the other end of the bridge. That is where the structure is perfectly balanced in the simplest manner. The most pleasing design is where the centre of the bridge is at the centre of the middle span, or it may be stated as a fundamental principle that an artistic bridge must have an unequal number of spans—one, three, five, or seven in number; but beyond seven spans the eye does not so readily grasp the whole and seek for an opening instead of a pier at the centre. Likewise the spandrel arches of an arch bridge must be three, five, or seven in each half of the span, or where they extend across the key stone, an unequal number for the whole span.

Proportion is most nearly reached when the whole structure is most pleasing to the trained eye, and the truth most closely adhered to in every part of the structure and in every detail. The use of too great a sag in a suspension bridge, or of too great a rise in an arch bridge dwarfs the apparent length of such a span. That is, too great for appearance, even if not too great for economy.

Careful Study Needed.

We must remember that there is nothing really in common between the architecture of buildings and the artistic design of bridges. The lack of any attempt at artistic

*From an address delivered before the Civil Club, University of Toronto.

design in the Williamsburg suspension bridge is deplorable; the failure to complete the towers of the Brooklyn Bridge is deplorable; the attempt at an artistic design for the Manhattan bridge produced a structure which is only not unpleasing; but in the Hell Gate arch we have a structure which is of great simplicity, of real harmony, of true symmetry, and perfect in proportion. It is not often given to man or to the engineer, to attain nearly to perfection, seldom more than once; but by careful study and thought, we can obviate very many flagrant violations of the artistic in the design of our bridge structures.

SUBURBAN PROBLEM OF GREATER WINNIPEG

Evils Following Boom Subdivisions — Heavy Tax Burden For Local Improvements and Schools in Suburban Municipalities — Zoning and Greater Winnipeg Plan Advocated.

SUBURBAN problems of large cities with particular reference to Winnipeg were discussed in an Informing address by W. E. Hobbs, Comptroller of Town Planning, Province of Manitoba, at the recent annual meeting of the Town Planning Institute of Canada, in Ottawa. The address, in which considerable detail was given, both in the nature of figures and plans, is abstracted briefly below.

Mr. Hobbs pointed out the difficulty hampering the proper development of Winnipeg through the original layout of lots and streets. The narrow "River Lots" and their extension into "Lots in the Outer Two Miles" running roughly at right angles to the Red and the Assiniboine Rivers have governed the city plan to an unfortunate extent. As a consequence straight streets 50 ft. wide and two to four miles in length have become the rule in Winnipeg and the surrounding district, with lanes 16 ft. wide midway between them, and lots 99 ft. deep fronting on them regardless of the function which streets, lanes or lots expected to fulfil.

Except in the case of St. Boniface, the development of suburban municipalities adjacent to Winnipeg was slow until after 1905. In the period from 1912 to 1915 there was a particularly rapid growth in the suburban municipalities.

Boom Subdivisions.

In the period from 1910 to 1914 an amount of suburban land was converted into building lots far in excess of the present or future requirements of the population for many decades to come. The result is that only a small percentage of suburban municipalities are built up, in the case of the rural municipality of Fort Garry amounting to only 0.45%, and in the case of St. James, the most built up of these municipalities, amounting to only 6.8%. Of the area of Winnipeg proper only 41.3% is built up. These figures were established by Mr. Hobbs by assuming a population of 32 persons to the acre on the built-up portion and determining the percentage of area that would need to be occupied by the 1921 population.

During the years of unrestricted subdivision, lots and streets were laid out without regard to the uses to which they were to be put. The relative functions of main and secondary highways received no consideration; lands that might have become attractive residential areas were spoiled for that purpose and those that should have been set aside for industrial purposes were given over to other uses. No parks or recreation grounds were appropriated or apparently ever given a passing thought. Unfortunately, a sufficient number of these lots have been built upon to fix the form of the layout so that it is not difficult to secure a more advantageous arrangement except in cases of urgent necessity.

Lower prices of land and lower initial taxes naturally drew people from the city to the suburban municipalities. In most cases those who moved out were people of small or very moderate means. Back from the main highways, often a mile or more, land of apparently little residential

value was sold at a price enabling the poorest people to buy it, so that the development has naturally been widely scattered.

Increase In Suburban Taxation.

Since 1915, when the period of depression really set in, the saleability of suburban lots has diminished, while municipal taxes have increased enormously. Added to the effect of the war, were the costs of numerous local improvements such as sewers, water supply, etc. To lessen the burden of taxation some municipalities have made efforts to increase their population, but with indifferent results.

In a typical suburban municipality cited by Mr. Hobbs, there were in 1921 only 6,396 people while at the same time there were nearly 27,000 building lots, an excess of nearly 25,000 lots. When farm lands are withdrawn from production to be subdivided into building lots that are not required, an economic loss results. Soon the tax burden becomes so great that many of the lots are allowed to revert to the municipality through tax sale proceedings. This is particularly true for the poorer lands, and the municipality finds itself saddled with a great many unsaleable building lots against which no taxes can be levied. Where there are local improvements charged against lots they have to be met out of the general revenue. This situation was largely the cause of the town of Transcona being placed in the hands of an administrator some two years ago.

Local Improvement Burden.

Even though development of suburban areas may be highly scattered, it is necessary where a considerable number of houses are grouped together to provide water and sanitary conveniences. To connect these outlying areas may involve the construction of half a mile or more of entirely unproductive sewers or water mains which have to be charged up against the lands affected. If, as was pointed out by Mr. Hobbs, development were regulated, it would not be necessary to provide roads, sidewalks, sewers, and water mains capable of serving fifty or more houses for the benefit of possibly three or four.

School Tax Problem.

Experience has shown, stated Mr. Hobbs, that in the municipality cited, the tax increase is due more to the cost of operating schools than to the other matters mentioned. As school taxes are paid on vacant lands as well as on buildings, the average value of new dwellings must be great enough to produce revenue for school purposes equal to the increase in school expenditures caused by the children living in them if the school rate is to remain the same. In the particular community mentioned as an example by Mr. Hobbs, it was found that while the average additional revenue realized by the construction of each new house was \$27, the increased school expenditure arising from the necessity of providing school accommodation for the normal percentage of children was found to be \$75.50. In another case, each new house produced on an average \$13 for school purposes, whereas the increased expenditure involved was approximately \$76.

To meet the heavy burden of the cost of schools the municipal financier counts to some extent on the construction of the more expensive buildings. Costly dwellings and industrial buildings bear a share of taxation in excess of that required for school purposes, so that a municipality naturally should attempt to attract the well-to-do to live within its boundaries, and, in so far as possible, to encourage the establishment of industries. Unfortunately, suburban municipalities are not self-contained, the larger business or industrial buildings being located in the city proper, so that unless a suburban municipality contains a larger number of expensive residences, it has difficulty in meeting school expenditure without a heavy tax rate.

Zoning As a Remedy.

Mr. Hobbs advocated zoning as a partial remedy for the ills suffered by Winnipeg as a result of unfortunate and

unregulated development. Farm and garden lands should be declared an arable zone so that municipal taxes on such land could be reduced and they could be used for the purpose at which they are at present best suited. Residential zones should be set up and commercial and industrial requirements should be met by the establishment of zones for them. Regulations should be established governing all future subdivisions, so framed as to bring the cost to the community of its development to the lowest possible level. One municipality has already adopted regulations requiring that in the case of a proposed subdivision, if the municipality cannot see its way to instal sewer and water facilities forthwith, it will not approve of the subdivision, unless the applicant will provide these facilities at his own expense. If he is not willing to do this, he may subdivide his land into lots sufficiently large to insure healthful conditions without the provision of sewer and water facilities, in which event a restriction of one house to a lot would be imposed.

Greater Winnipeg Plan.

The need for a Greater Winnipeg plan embracing the city and suburban municipalities was pointed out by Mr. Hobbs. The need for preventing the construction of a ring of factories around the city is one of the urgent features of the situation, as is also the desirability of insuring the best use for residential purposes of areas suitable for such.

HILGER CHEMICAL SPECTROMETER.

AN entirely novel spectrometer designed for chemical analysis, called the Hilger chemical spectrometer, has been placed on the market by Adam Hilger, Ltd., 75A Camden Road, London, N.W., England. Although the spectroscope has been known from the time of Kirschhoff and Bunsen, and has been in use by chemists ever since, it is not yet in daily use in most chemical laboratories. Various reasons for this can be enumerated, such as initial cost of the equipment, the large space required to instal it, the want of an agreed and convenient technique connected with the production of emission spectra, the need of calibration, and, finally, the absence of suitable tables giving the wave-lengths of the lines characteristic of elements. In designing the Hilger spectrometer, these points have been borne in mind, and as a result, an instrument has been produced which is not only substantially cheaper than this company's constant deviation wave-length spectrometer, but is also compact, taking up less table space, and convenient to manipulate. Another feature is that the readings are direct in wave-lengths, to an average accuracy of 0.15 micro-millimetres (1.5 Angstrom units.)

HAMILTON ENGINEERS ELECT OFFICERS.

ELECTION of officers at a recent meeting of the Hamilton Branch of the Engineering Institute of Canada resulted as follows: Hon. chairman, H. U. Hart; past chairman, E. H. Darling; chairman, F. W. Paulin; vice-chairman, J. W. Tyrrell; secretary-treasurer, W. F. McLaren; Committee, H. G. Bertram, J. J. Mackay, P. M. Smith, C. H. Marrs, ex-officio, E. R. Gray.

The secretary, W. F. McLaren reported that the membership of the branch had increased from 160 to 170 and that the finances were in good shape. During the year nine meetings were held and addresses delivered by prominent engineers on live topics.

At the annual meeting of the Nova Scotia Mining Society, held at Sydney, N.S., on May 29, the following officers were elected: George D. MacDougall, president; C. M. O'Dell, first vice-president; A. S. MacNeill, second vice-president, and E. C. Hanrahan, secretary-treasurer.

HUMPBACK RESERVOIR OVERFLOW COMPLETED

CONSTRUCTION of the Humpback reservoir overflow, estimated to cost the city of Victoria, B.C., about \$18,000 is practically completed. The project has been under way since January, and most of the work was done in the form of relief by men who applied to the city for employment.

The steel pipe section of the overflow will form when completed the longest homogeneous section of steel pipe on the Island, being without calked or bolted joints, all connections being made by welding. The main flow lines through which Victoria's water supply flows, are of concrete. The total length of steel used in the overflow is 1,960 ft. The entire length of pipe is buried to a depth of about 3 ft. to the top of the pipe. This is necessary owing to there being no provision for expansion of joints. The method of construction adopted was to fabricate the pipe in the shops in 20 ft. lengths. All welding was done by the oxy-acetylene process.

DIAGONAL TRAFFIC ARTERY AT OTTAWA

OTTAWA in its layout — its mesh of streets — suffers as all other Canadian and American cities from the over-expansion of the checker-board system and its resultant indirection between most of the important objectives.

York St. in Lower Town extends for four blocks and through the market area from Sussex St. easterly with a convenient width for its purpose of 132 ft. to King Edward Ave. Beyond King Edward Ave. it is proposed to continue it on a similar width for some distance and then gradually diminish the width to 80 ft. for the last 500 ft. approaching St. Patrick St. Bridge. The proposed widening and extension as a diagonal will provide a direct access for heavy and market traffic from East of the Rideau River to the



TRAFFIC DIAGONAL AT OTTAWA

market and the centre of the city. Moreover, the scheme will relieve the city of the otherwise inevitable widening of St. Patrick St. in a few years at many times the cost and disturbance. The new diagonal, which is over 3,000 ft. in length, disturbs few houses of any value and will remove many undesirable fire-trap structures and prove a valuable fire-break across the city.

Mr. Cauchon, the chairman of the Plan Commission, in a recent lecture in By Ward, strongly advised those affected to initiate action under local improvement by-law and reap the benefits of the improvements in traffic conditions and enhanced values which would follow. It is intended to have a square at the approach to the bridge that traffic may be segregated and directed without delay or confusion. The St. Patrick St. Bridge is one of the handsome new concrete bridges just completed across the Rideau River, by the works department of the city. The illustration shows the diagonal traffic artery proposed by the Plan Commission.

A recent compilation by the U. S. Bureau of Records, on the cost of various types of road pavement, covers 63 million square yards of paving constructed with Federal aid in all parts of the United States from 1916 to 1921. The following square yard costs of paving are average figures only: Sand-clay, 18c; gravel, 46c; plain and surface-treated macadam, 95c; bituminous macadam, \$2.10; bituminous concrete, \$2.50; plain cement concrete, \$2.57; reinforced cement concrete, \$2.74; and brick, \$4.10.

Engineer's Library

INDUSTRIAL LIGHTING BRIEFS—The Cooper Hewitt Co., Hoboken, N.J., are distributing from time to time a series of Industrial Lighting Briefs which contain interesting matter relative to the subjects of light and lighting. One of the more recent bulletins issued, deals with "Industrial Lighting in Theory and Practice."

THE CENTURY WOOD PRESERVING CO., Pittsburgh, Pa., Bulletin No. 21 which has just been issued by this company contains some interesting information on the adzing and boring of cross ties before treatment. The adzing and boring of cross ties before treatment has been practiced in Europe for some years, but it is only within the last few years that this practice has been adopted on this side of the water. The bulletin is nicely illustrated and will be found of interest to all those who are concerned with the maintenance of railroads.

SOUND PROOF PARTITIONS.—By F. R. Watson, Professor of Experimental Physics, University of Illinois. Bulletin No. 127, Engineering Experiment Station, University of Illinois, Urbana, Ill. Paper: 6 by 9 in.; pp. 78; illustrated. The bulletin is the outcome of an effort to discover ways and means of producing quiet rooms in hospitals, hotels, office buildings, music studios and the like. Much valuable information is collected and presented in a systematic way giving the methods and results of various investigations relating to the actions of materials with respect to the transmission of sound.

THE PORTABLE MACHINE CO., OF PASSAIC, N.J., has just issued an interesting folder illustrating and describing the contractor type of scoop conveyor, which is particularly adapted to the construction of concrete roads. This new machine is designed particularly for the handling of crushed stone, sand and gravel, and is based upon the results of actual experience which the company had in the manufacture of portable belt conveyors for many different operating conditions. Those interested in the design, construction and maintenance of roads will find the leaflet exceptionally interesting and a copy can be had for the asking.

THE DESIGN AND CONSTRUCTION OF DAMS, including masonry, earth, rock-fill, timber, and steel structures; also the principal types of movable dams.—By Edward Wegmann, New York, John Wiley & Sons, Inc.; London, Chapman & Hall, Ltd. Seventh edition; pp. 555, 210 figures; 16 folding plates; 9 by 11½ in.; cloth; \$10 postpaid.

Thirty-four years have passed since the first edition of this book—a treatise of 106 pages, discussing only the subject of masonry dams—was published. Only trifling additions were made in the second and third editions, but in the fourth, which appeared in 1899, the scope of the book was enlarged so as to include the design and construction of masonry, earth, rock-fill, timber and steel dams, and, also, the principal types of movable dams.

In the fifth edition, published in 1907, the subjects of dams of reinforced concrete, rolling dams and Stoney gates were added to the book, and in the sixth edition the volume was enlarged so as to include two new chapters: One on overflow weirs and the other on coffer-dams, besides descriptions of recent dams.

So many important dams have been built of late years, in various parts of the world, and so much new information has been published about dams of all kinds, that a new edition of this book became necessary. It in-

cludes a new chapter on "Crest-gates and Siphon Spillways," important subjects about which very little has hitherto been published, and also additional descriptions of recent dams, and bibliography to bring the book up to date.

Among the subjects of interest included in this edition may be mentioned:

A full description of the construction of the Kensico Dam, New York, which has surpassed all previous records in the rate of progress; the movable dams of the N. Y. State Barge Canal; high dams built recently in Spain, one of which, the Camarasa dam, about 335 feet high above its lowest rock foundation, is at present the highest gravity dam in the world; automatic crest-gates of the hinged-leaf type, some of them 88.6 feet wide by 21.6 feet high; and siphon spillways, built both in America and abroad. To the sixth edition, which was published in 1911, have now been added about 50 pages of text, 34 figures in the text, and 5 plates. The new matter included in the present edition will prove to be of interest and value to engineers and contractors.

DICTIONARY OF APPLIED PHYSICS.—Edited under the supervision of Sir Richard Glazebrook, K.C.B., F.R.S., and published by The MacMillan Company of Canada Ltd., Toronto. Five volumes. The first volume of this most important work is now ready for distribution in Canada and the succeeding volumes will appear at intervals of from two to three months. The volumes contain from 800 to 1000 pages each and have been arranged as far as possible in subjects, as follows:

Vol. I Mechanics, Engineering and Heat.

Vol. II Electricity.

Vol. III Meteorology, Metrology and Measuring Apparatus.

Vol. IV Optics, Sound and Radiology.

Vol. V Metallurgy and Aeronautics.

The arrangement in each volume is alphabetical but each subject is dealt with in a continuous article. In this Dictionary, the first attempt has been made to bring within the compass of a single work, the latest results of research and the most approved methods in all branches of the subject. It will prove invaluable to all manufacturers who are vitally concerned with the question of physics as applied to industry, which has become so important during the past few years. The experience of the War has enforced more strongly, the lessons thus taught and the importance of applied science is now universally admitted.

THRUST BEARINGS.—Catalogue C. 72 pages and cover, 6 by 9 in., 62 illustrations; issued and distributed free upon request by the Kingsbury Machine Works, 4320 Lackawanna St., Frankford, Philadelphia, Pa. This new issue of the Kingsbury catalogue has been entirely re-written and includes much new matter of considerable value to the users of thrust bearings and to engineers generally. The section of the catalogue that will be of particular interest to Canadian engineers is an illustrated description of the Kingsbury thrust bearings installed in the Queenston plant of the Hydro-Electric Power Commission of Ontario. Other interesting features are the announcement regarding standardization of dimensions of Kingsbury bearings, the guarantee regarding power or friction loss, the illustrated description of the combined vertical thrust and journal bearings, the illustrated description of the propeller thrust bearings, a valuable technical and mathematical discussion of actual power loss determinations and of standardization of power losses. The catalogue is illustrated with a large number of interesting views of power stations in the United States and Canada, sectional drawings of various types of bearings, and photographs of typical bearings. It also contains a considerable amount of practical as well as technical information regarding the selection, installation and operation of thrust bearings.

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SPECIAL MOTIVE POWER FOR STEAM RAILWAYS.

NEW developments in combination motor and passenger cars for branch line steam railways are occurring with notable frequency. We have had occasion to mention from time to time the commendable pioneering spirit shown by the Canadian National Railways in adapting the gasoline motor and the storage battery to the propulsion of motor cars for its branch lines. A type of gasoline car in advance of those previously tried out is now under construction for the Trenton-Picton line. So popular was the gasoline car service on the Brockville-Westport line that when the car was taken off for overhauling, representations were made to have the service restored, and such is being done. Reports of operation of the storage battery cars between Bathurst and Campbellton on the Canadian National Railways are also encouraging. It is of interest to note also that the Greater Winnipeg Water District is establishing a gasoline motor car passenger service on the 92 miles between St. Boniface and Shoal Lake.

Experience appears to show that the railway motor car made up by merely putting a car body and a set of flanged wheels on a standard motor truck is not satisfactory. Such a car will not stand the service requirements and consequently a new type is being tried out with four axles giving groups of four wheels at each end. The double pair of rear wheels will, it is hoped, give sufficient traction to propel a car through a snow storm, or with ice on the rails. As operation under winter conditions has been one of the principal drawbacks to the extension of gasoline propulsion on branch lines in this country, the new developments will be looked upon with great interest by Canadian railway engineers.

AESTHETIC STANDARDS FOR BRIDGES.

FOUR artistic essentials in the design of bridges are laid down in the article by Charles Evan Fowler appearing elsewhere in this issue. That these are of fundamental application and importance cannot be doubted, and if a structure is designed with due regard to them it should go far towards satisfying the public taste. It is probably true that more aesthetic monstrosities in bridge work occur through ill-advised attempts at ornamentation than from any other cause. It is quite true, as the writer points out, that the historical origin of architectural details is not of itself an important factor, but at the same time care must be taken to ensure that the detail is suitable for the kind of construction in which it is used. It is, for example, not desirable to employ in a steel structure details that in their general lines wholly belong to masonry construction.

Nor is it permissible to mask a truss span with a false fascia construction simulating the lines of an arch.

Study of bridge design, good and bad, leads to the inevitable conclusion that the chief beauty arises from the general form and not from added ornamentation. A concrete arch span with a sharp break in grade at the crown is essentially displeasing, no matter what the surface treatment may be. No amount of attempted beautification can compensate for faulty lines, lack of symmetry or unbalanced proportions.

THE ENGINEER IN PUBLIC LIFE.

FREQUENT regrets are expressed in the technical press and in engineering circles, that the engineer does not take a more active part in public affairs. It is pointed out that when a public office is filled by election, it is generally a lawyer, merchant, banker or politician who is elected. In many cases, the particular post is such as to make it most desirable that an engineer should be selected to fill it, and nevertheless, there appear to be too few engineers who announce themselves as available for public office, or who seek preferment of this kind.

An interesting departure, calculated to encourage the entry of engineers into public life, is the publication by Engineering News-Record, of short biographical sketches of engineers who have recently been prominent in connection with non-professional activities. The object is to draw the attention of the profession to those of its members who have been selected as mayors, members of city councils, members of legislatures or chairman of important committees concerned with public or philanthropic undertakings. The step thus taken is a most commendable one and should have a salutary effect. The profession should know of all cases where its members have won distinction in fields not directly connected with technical work, and an extension of such activities is something that should be encouraged in every possible way.

PERSONALS

CAPT. F. P. STEERS has taken up his residence in London, Ont., to start on the 1922 section of the London Geodetic Survey.

GEORGE D. MACDOUGALL, chief engineer of the British Empire Steel Corporation, has been elected President of the Nova Scotia Mining Society.

GABRIEL HENRY, former chief engineer of the department of roads, Quebec, is now consulting engineer. M. NECKAR has been appointed to the position of chief engineer.

R. A. PARRISH is now general organizer and publicity agent of the Edmonton Automobile and Good Roads Association, having been appointed to this position, recently, for a three months term.

JOS. L. BOULANGER, former secretary to Hon. J. L. Perron, Quebec Minister of Roads, has been appointed deputy-minister of that department to succeed Ben. Michaud who has resigned owing to ill-health.

A. B. MANSON, city engineer of Stratford, Ont., recently observed the tenth anniversary of his appointment to that position. Mr. Manson entered the service of the city on June 1, 1912, coming from the Canadian Northern Railway.

E. T. CORKILL, mines superintendent for the International Nickel Corporation, Copper Cliff, Ont., has left Sudbury and will reside in Toronto. Mr. Corkill joined the staff of the company as safety engineer in 1913 and in 1918 was promoted to the position of mines superintendent.

H. JARDINE, of Hespeler, Ont., has been appointed assistant city engineer of Galt, Ont., filling the vacancy caused by the resignation of ROY PATERSON. Mr. Jardine is an honor graduate of Queen's University, and served overseas with the C.E.F. He was for a time assistant engineer for the town of Timmins, Ont.

W. H. BISCHOFF, who was recently appointed general superintendent of the Dominion Iron & Steel Co., has arrived in Sydney, N.S. Mr. Bischoff, who replaces the late H. E. Price, was formerly assistant general superintendent of the Dominion Iron & Steel Co., but left in 1919 to join the Lubin Iron & Steel Co., Coatesville, Pa.

NORMAN J. GOEBEL, formerly water works engineer at Oshawa, Ont., has joined the staff of Code & Code, consulting engineers, Windsor, Ont., and is in charge of the construction of asphalt pavements and water works extensions for the town of Kingsville, a summer resort on Lake Erie. This work involves the expenditure of approximately \$200,000.

ROSS L. DOBBIN, the newly elected chairman of the Canadian section of the American Water Works Association, was educated in the public and high schools of Peterboro, Ont., and graduated from the Faculty of Applied Science, Toronto University in 1910, with the degree of B.A.Sc.

After graduation Mr. Dobbin was employed for a short time at the works of the Dominion Bridge Co., Lachine, Que. as resident shop inspector for the Canadian Inspection Co.

In the fall of 1911 he went to Moose Jaw, Sask., as resident engineer for Walter J. Francis & Co., on the new water supply for that city. On the completion of that work he returned to Toronto in 1914 where he acted as erection inspector for the Dominion Inspection Co., on the steel work of the Royal Bank Building.

In June, 1914, he returned to Peterboro as waterworks superintendent for the Utilities Commission, and has remained in that position ever since. During that time he has supervised, among other things, the installation of a steam auxiliary pumping plant, and a six million gallon filter plant.

Mr. Dobbin is a member of Council, Engineering Institute of Canada, and also vice-chairman of the Peterboro branch of that body.

M. A. POOLER, who was recently appointed general manager of the New Brunswick Power Co., St. John, N.B., has had fifteen years' experience in the public utility field in the United States. He is a graduate engineer of Case School of Applied Science, Cleveland, Ohio, and Purdue

University, Lafayette, Indiana. After completing his engineering training, Mr. Pooler was engaged for several years with the Pennsylvania Ohio Power Co. For the past eight years Mr. Pooler has been general manager of the Potomac Public Service Co. Mr. Pooler has for many years been closely associated with the firm of Sanderson & Porter, of New York, which company will direct the management and operations of the New Brunswick Power Co.

S. E. REAUGH will survey and report on the proposed Jasper highway for the Edmonton Automobile and Good Roads Association. Mr. Reaugh has had much experience in his particular line of work. He was engineer in charge of location and construction of work on the Denver and Rio Grande Railway, and also on the Rio Grande Western. He held a similar position on the Colorado & Midland Railway. As an engineer under the Department of Railways and Canals of the Dominion Government, he had charge of two-thirds of the work on the Canadian National grade between Edmonton and British Columbia boundary, and when the rails were lifted, built the fifteen miles of road on the grade which is now in use from Lobstick Junction to Leaman. More recently he has been a resident engineer for the Alberta Provincial Government.

OBITUARIES

EDWARD BOTT, prominent builder and contractor of Toronto, died at his home in that city on June 3, aged 51.

ROBERT W. COX, civil engineer, died in Toronto on June 2, aged 46. The deceased who was a native of Lincoln, Nebraska, had resided in Toronto for 20 years.

JOSEPH H. OUELETTE, contractor of Sandwich, Ont., died in that town recently, aged 82. The deceased was born in Essex County and had lived in Sandwich nearly all his life.

SAMPSON J. BOTTOMLEY, contractor, died in Edmonton, Alta., recently aged 72. The deceased had lived in Edmonton about 12 years, having previously resided in Toronto.

CHARLES GARDEN, who died recently at St. John, N.B., aged 71, was in charge of work on different sections of the C.P.R. during the construction of that road through the Rocky Mountains. Mr. Garden was born at Woodstock, N.B.

BIG WATER WORKS CONVENTION 1923

AN important event for the border cities next year will be the annual convention of the American Water Works Association at Detroit and the meeting of the Canadian section A.W.W.A. at Windsor. It is planned to hold the Canadian convention a few days prior to that on the American side; both conventions being scheduled to take place early in June. By this arrangement Canadian water experts will have the added opportunity of attending the large American meeting in Detroit where they will be in a position to glean valuable data from the experience of a large number of prominent engineers who will attend the convention. Many problems dealing with the water supply of the Canadian Border Cities and Detroit will be discussed at next year's convention, where first hand engineering advice from the assembled experts of the continent will be available.

Commanding a party of British mining experts and backed by British capital, H. L. F. Blake, Ottawa, mining engineer, has set out for the wilds of Ungava, on a prospecting trip. His operations will centre on Lake Chibougamau, on the southern border of the territory, and his party will consist of four or five Brits and a dozen Indians of the Matanus tribe. Mr. Blake expects to stay in Ungava until October or November. He is a director of the Quebec and Chibougamau Railway, owned by British interests, and his present efforts pertain to the interests of the railway.



CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Nassau, New Providence, Bahamas, dredging	July 15	May 9
Revelstoke, B.C., construction of bridge	Jun. 19	May 23
Revelstoke, B.C., substructure of bridge	Jun. 19	May 30
Oakville, Ont., additions and alterations to Methodist Church Sunday School	Jun. 15	May 30
Ottawa, Ont., construction of female help building, Ottawa Civic Hospital	Jun. 15	May 30
Toronto, Ont., construction of concrete structures	Jun. 14	May 30
Saskatchewan, Province of, concrete bridges	Jun. 19	Jun. 6
Thorold, Ont., supply of cast iron water pipe and special valves and valve boxes, hydrants and for trenching	Jun. 15	Jun. 6
Kinloss Tp., Ont., construction of Ross Drain	Jun. 15	Jun. 6
Montreal, Que., work on wharves and pier	Jun. 15	Jun. 6
Halifax, N.S., construction of Halifax-Amherst Road	Jun. 20	Jun. 6
Malahide Tp., Ont., erection of steel bridge	Jun. 15	Jun. 6
Quebec, Province of, construction of road from Quebec to Ste. Anne de Beaupre	Jun. 23	Jun. 6
Quebec, Province of, construction of oiled waterbound macadam on a number of roads	Jun. 27	Jun. 6
Saskatchewan, Province of, construction of earth road from Canora west six miles	Jun. 21	Jun. 6
Sullivan & Elderslie Tps., Ont., construction of steel bridge, abutments and floor	Jun. 15	Jun. 6
Vaughan Tp., Ont., construction of reinforced concrete truss bridge	Jun. 17	Jun. 6
Chippawa, Ont., construction of concrete sidewalks and street crossings	Jun. 20	Jun. 6
Colborne, Ont., construction of High School	Jun. 14	Jun. 6
Kitchener, Ont., construction of Collegiate Institute and Vocational School	Jun. 15	Jun. 6
Lachine, Que., supply of transformers, oil switches, switch board panels, etc.	Jun. 15	Jun. 6
Oakville, Ont., laying of cast iron suction pipe, constructing extension to pump house and furnishing and erecting gasoline or oil engines, turbine pumps and electric generator	Jun. 22	Jun. 6
Port Credit, Ont., construction of addition to school	Jun. 15	Jun. 6

BRIDGES, ROADS AND STREETS

Brant Tp., Ont.—Contracts for construction of bridge over the Saugeen River on 6th Concession Road for Bruce County Council have been awarded as follows: Steelwork to the Hunter Bridge & Boiler Co., of Kincardine; concrete work to Jacob Palin, of Mildmay. Total cost, about \$22,000. Fred B. James, of Walkerton, is consulting engineer in charge of this work.

British Columbia, Province of.—Thirty-seven miles of road are to be constructed between Avola and Blue River. work.

British Columbia, Province of.—Contract for construction of Nelson-Ymir Road has been awarded by the Public Works Department to DeWolf and Ham, of Cranbrook, B.C.

British Columbia, Province of.—Tenders will be received by the Honorable the Minister of Public Works, Victoria, until noon, Monday, June 19, for the erection of two 60-ft. span King trusses in Lulu Island Bridge, Eburne. Plans and specifications may be seen at the office of Government Agent, Vancouver; District Engineer, New Westminster; and the Department of Public Works, Victoria.

Birch Cliff, Ont.—Suggestions will be offered at the next meeting of the council for the immediate widening of Kingston road from Stop 12 to the new Danforth extension at Stop 24, and more especially between the present congested area of Stop 18 to 20.

British Columbia, Province of.—Highway Department plans to improve the Hastings-Barnet Road. Chief Engineer, P. Philip, Victoria.

Dereham Tp., Ont.—Tenders closed June 12 for construction of five reinforced concrete bridges. J. D. Flanders, Township Road Supt., Dereham Centre, Ont.

East Nissouri Tp.—Tenders for abutments for bridges at Lot 35, Townline, between East Nissouri and West Zorra Townships, according to plans and specifications prepared by F. J. Ure, C. E., Woodstock, Ont., will be received until 12 o'clock, June 17.

East Nissouri Tp., Ont.—Tenders for building a concrete bridge at Lot 5, Concession 8, will be received until June 29. Plans and specifications may be seen at S. Tye's place, Lot 16, Con. 9, Clerk, J. W. Sutherland, Lakeside, Ont.

Etobicoke Tp., Ont.—Tenders closed June 5 for construction of concrete sidewalks on Douglas Ave. and Queen St., and grading on Queen St. Township Engineer, Frank Barber, Toronto.

Fencelon Falls, Ont.—A concrete pavement is to be constructed on Colborne St. and on Lindsay St. Clerk, E. Fitzgerald.

Hamilton, Ont.—Wentworth County Council awarded contract for concrete pavement on Binbrook Road to the King Engineering & Construction Co., of which W. W. King, of Oakville, is General Manager.

Islington, Ont.—Contracts for grading and construction of sidewalks on Queen and Douglas Streets were awarded to A. Johnson.

Knowlton, Que.—Contract for construction of iron bridge between the Townships of Sutton and Brome has been awarded to C. J. Dryden Co., Ltd., Montreal, for \$5,250. Tenders were also received from K. B. Jenckes, Sherbrooke, and Albert & Edouard Cote, Johnville, Que.

London, Ont.—Street Railway Co. is being urged by the city to pave its portion of certain streets on which there are street railway lines.

London, Ont.—Manager Buchanan of the Utilities Commission, has requested that City Engineer H. A. Brazier

construct a road in Springbank Park for the Commission.

Madahide Tp., Ont.—Tenders addressed to James A. Bell & Son, Civil Engineers, Court House, St. Thomas, Ont., will be received until noon, June 15, for furnishing material and erecting a 300-ft. steel bridge on concrete foundations over Stalter's Gulley, Nova Scotia St. Plans and specifications may be seen at office of engineers.

Mimico, Ont.—Town Council awarded contract to E. C. Hoffman for road work on Superior Ave., Robert Street and Eastbourne Ave.

Montreal, Que.—Director of Public Works has called for estimate of cost on paving rear lanes in city. Ald. Brodeur announced that a start would be made on the work this season.

Montreal, Que.—City Council let following contracts for supply of road oil: Sun Co., 60,000 gallons at 8½c. per gal.; The Barrett Co., Ltd., 90,000 gallons to be supplied and also laid for 16c. per gal.; and J. F. R. Leduc, 45,000 gallons to be supplied and laid for 16c. per gal.

Mosside, Alta.—Council decided to purchase four new road graders.

Normandy Tp., Ont.—Contract for construction of three girder bridges has been awarded to the Stratford Bridge Co., Stratford, for \$4,630.

North Oxford Tp., Ont.—Contract for grade in connection with erection of bridge was awarded to Geo. Wilks, Woodstock, at \$1,500, and for the abutments to Frank Fogarty, Ingersoll, at \$1,615.

Ontario, Province of.—A provincial highway is to be built from Port Erie to Port Colborne connecting with the concrete highway to Welland.

Ontario, Province of.—J. J. McNab, Trenton, was recently awarded the contract for the construction of all culverts on the Provincial highway in Prince Edward county, between Belleville and Picton. The amount of the contract is about \$18,000.

Ontario, Province of.—Highway Dept. is calling for tenders for the paving of a 20-ft. strip of roadway on the west side of the radial tracks on Yonge St., Toronto, from the Mausoleum to the southern end of the paved stretch at Newmarket.

Paris, Ont.—The estimated expenditures for this year include the following items: Street oiling, \$2,000; streets, roads and bridges, \$7,000; and concrete walks, \$500. Clerk, C. B. Barker.

Peterboro, Ont.—Board of Works tabulated a list of proposed repairs and improvements on streets which they sent on to Council for approval. City Engineer, R. H. Parsons.

Petrolia, Ont.—Hon. F. C. Biggs, Minister of Provincial Public Works and Highways, will be asked to designate the county road from a point south of Rutherford to Reece's Corners in Plympton Township, a provincial highway.

Point Grey, B.C.—Tenders closed June 6 for construction of concrete sidewalks. Henry Floyd, Municipal Clerk, Kerrisdale, B. C.

Quebec, Province of.—Orders have been issued by the Highway Department providing for the immediate repair of roads in the vicinity of Quebec, including Lake St. Charles, Lake Beauport and Loretteville Roads. Minister of Highways, Hon. J. L. Perron.

Quebec, Province of.—Urging the construction of a Provincial highway from Quebec to Chicoutimi, a delegation including all the mayors of the parishes of that section, headed by Hon. Emile Moreau, waited on Premier Taschereau and fully explained the project. The road would be 150 miles long.

Quebec, Province of.—Contracts for construction of roads awarded by Highways Department as follows: Montreal-Sherbrooke Highway, Oxford Township, 3 miles, to C. Gauthier, Weedon. Rock Forest, 9½ miles to C. Gauthier; Lake, F. Larouche, Coaticook, Magog Township; Rousseau & Guertin, Dastinan & Sheffers Township, 12 miles, Nova Scotia Construction Co.; Waterloo (Town), 9 miles, Nova Scotia Construction Co.; St. Cesaire, parish and vil-

lage, Montreal Road Construction Co. Levis-St. Laurent-St. Lambert-Sorel section, Varenne, 3 miles, J. Trudeau, Varrennes; Vercheres, 3½ miles, Napoleon Trudel, Contrecoeur, 11 miles, H. St. George, Huntingdon; St. Roch, St. Ours. Ste. Victorie and St. Pierre de Sorel, 12 miles awarded to Compagnie de Construction de St. Ours. Contracts for repairs have been awarded to O'Connor Bros. for all roads in Chateauguay, Beauharnois, Huntingdon and La Prairie counties.

Quebec, Que.—Following contracts were awarded by Board of Works for construction of pavement: T. I. Bilo-deau, St. Marie St., concrete, \$2.11 per sq. yd.; Marchand St., granite blocks, \$5.89; Turnbull Ave., granite blocks, \$5.89; Deligny St., concrete, \$2.11; D'Artigny, concrete, \$2.11; Q. A. A. St., concrete, \$2.14; Dosquet St., concrete, \$1.89. To Dominion Paving Co., Belvedere Road, warrenite, \$3.74; Garneau St., warrenite, \$2.30; Herbert St., warrenite, \$2.36; St. Monique, warrenite, \$2.30; Laval St., warrenite, \$2.30. To Madden & Murphy, Des Fosses St., asphalt, \$2.90; Fleurie St., asphalt, \$3.47; Charest St., asphalt, \$3.47; St. Francois St., asphalt, \$2.75; Bayard St., asphalt, \$3.55; St. Ambrose St., asphalt, \$3.50; Falardeau St., asphalt, \$3.50; Jumonville St., asphalt, \$3.52; Carillon St., asphalt, \$3.52; Ste. Therese St., asphalt, \$3.52; Third St., asphalt, \$3.52. To T. Rousseau, 13th St., concrete, \$2.20; Sixth St., concrete, \$2.20; Royal Rouillon, concrete, \$2.24; Bougainville Ave., concrete, \$2.48; Rac Amadou St., concrete, \$2.24. To A. Demers, Laurier Ave., concrete, \$2.

Riverside, Ont.—Contract for construction of concrete sidewalk on Lauzon Road awarded to Carlottie Bros., Walkerville.

St. John, N.B.—It is proposed to extend Millidgeville Ave. to the river.

St. John, N.B.—Contract for supply of 20,000 granite blocks was awarded by Common Council to the Granite Street Paving & Construction Co., at \$80 a thousand. Other tenders received: Morrison & Newlands, at \$85 per thousand and B. Mooney & Sons, Ltd., at \$85 per thousand.

St. Lambert, Que.—Work is to be started soon on a bitulithic surface for Front St. and the River Road as far as the limits of St. Lambert, while the 1,700 ft. of unimproved surface in Montreal South is also to be reconstructed.

St. Mary's, Ont.—A. Devincy and E. Dunseith have secured a contract for the construction of a section of the Provincial highway between Ingersoll and Woodstock.

St. Thomas, Ont.—Construction of an asphalt pavement on Wellington St. from Ross to Elgin Sts., is planned City Engineer, W. C. Miller.

St. Thomas, Ont.—Construction work on proposed ravine driveway is to be started from the Hiawatha Street entrance shortly. City Engineer, W. C. Miller.

St. Thomas, Ont.—City Contract awarded contract to William Irwin & Son for construction of 6,000 sq. yds. of bituminous macadam roadway at \$2.02 per sq. yd. The same firm was also given contract for constructing curbs and gutters and concrete sidewalks in connection with the streets, their prices being as follows: Curbs and gutters, 80c per ft.; gutters, 43c and sidewalks, 21c. E. P. Cash was the only other contractor who tendered. His quotation on bituminous macadam roadway was \$2.30 per sq. yd.; curbs and gutters, 90c; gutters, 42c; sidewalks 22½c.

Saanich, B. C.—Council authorized paving of 1,000 ft. of Tyndall Ave. Clerk, H. S. Cowper.

Sandwich, Ont.—Hydro-Electric Power Commission of Ontario plans to grade the road between the car tracks on London St.

Saskatchewan, Province of.—Highways Department will build road leading into Plapot.

Saskatchewan, Province of.—Contract for construction of road from the N. E. corner of Section 36, Township 33, range 12, west of the 2nd Meridian to Wadena has been awarded to The Christian Community of Universal Brotherhood, Ltd., of Veregin, Sask.

Saskatchewan, Province of.—Contracts for the construction of bridges totalling over \$12,000 were awarded by

the Highways Department, as follows: John Kenward Co., Regina, construction of two 60-ft. reinforced concrete suspended arches at Drinkwater, \$7,778.60, and a 40-ft. reinforced concrete beam span east of Maple Creek, \$2,901; Levi Angst, of Cypress River, Man., 20-ft. reinforced concrete beam span west of Yorkton, near Willowbank, \$2,072.

Sioux Lookout, Ont.—On June 14 by-law providing for the raising of \$10,000 for construction of bridge, grading, etc., will be submitted to ratepayers. Clerk, J. E. Cole.

Sydney, N.S.—Council awarded contract for construction of Argyle Street bridge to McNeil & Lamond, of Sydney Mines, for \$4,190. Other tenders received: R. V. Hall, \$5,652; A. E. Cunningham, \$4,580; F. A. Morley, \$4,745; Chappell's Ltd., \$4,684.

Thorold, Ont.—Tenders closed June 3 for construction of 3,000 sq. yds. of concrete pavement with combined curb on Chapel St. Engineer, F. N. Rutherford, 24 Queen St. St. Catharines, Ont.

Toronto, Ont.—Works Committee again recommended the widening of Jane St. in West Toronto to 86 ft. at a cost of \$80,000.

Toronto, Ont.—Lowest tenders received by Board of Control for three sections of paving on Lake Shore Road total \$143,802.

Toronto, Ont.—City Council intends to construct a concrete walk on Don Roadway, East side from Eastern Ave. to Queen St., at a cost of \$2,910.

Toronto, Ont.—The proposal for a subway under the G.T.R. tracks at Ashdale Ave. was again presented to the Works Committee after being laid over for a year.

Toronto, Ont.—Board of Education has asked the Works Committee to construct sidewalks on Haig Ave., south of Coxwell Ave., in connection with the Earl Haig School.

Toronto, Ont.—City Council intends to construct asphalt pavement on Annette St., at cost of \$65,530; concrete curbing on Annette St., \$2,911; and concrete sidewalk on Knox Ave., \$639.

Toronto, Ont.—Board of Control requested Works Commissioner Harris to report as to the advisability and probable cost of extending Avenue Road to the northern limits of the city.

Toronto, Ont.—Works Commissioner Harris reported to the Board of Control that the tenders received for the construction of the new bridge over the Don at Gerrard St. are unsatisfactory, the prices quoted being too high.

Toronto, Ont.—Following contracts were awarded for construction of asphalt pavements: Oriole Gardens, Kilmer & Barber, \$7,128; Lake Shore Road, 3 sections: Constructing & Paving Co. \$41,193; Godson Contracting Co., \$61,866; Kilmer & Barber, \$40,743.

Toronto, Ont.—Works Commissioner R. C. Harris urged the members of the Civic Works Committee to reach a definite conclusion, at the earliest possible moment, regarding the widening of Yonge St. north of the C.P.R. tracks to Lawton Ave., so that there may be no unnecessary delay in the double-tracking of that thoroughfare as soon as the Transportation Commission is ready to proceed with the work.

Toronto, Ont.—The following tenders for the construction of the new bridge to be built over the Don River at Gerrard St. were opened by the Board of Control on May 31 and referred to Works Commissioner Harris for report: Roger Miller & Sons, Ltd., Toronto, \$743,781.22; Wells & Grey, Ltd., Toronto, \$739,272.60; and John E. Russell Contracting Co., of Toronto, \$721,519.88.

Toronto, Ont.—If suggestions made by Chief of Police S. J. Dickson to the Ontario Motor League materialize, the roadways of a number of the downtown streets will be widened from one to five feet to accommodate the growing volume of motor traffic. The proposals have been taken up by the executive of the Ontario Motor League and the Secretary, W. G. Robertson, has forwarded a letter to the Board of Control recommending their adoption.

Victoria, B.C.—Public Works Committee has been authorized to rebuild a 40-ft. bridge on Shelbourne St. City Engineer, F. M. Preston.

Victoria, B.C.—City Council agreed to let the C.P.R. construct a portion of the western approach of the Johnston Street bridge in accordance with terms approved by the Public Works Committee.

Victoria, B.C.—Contract for paving with concrete three miles of the Pacific Highway on the lower Mainland from the end of the present paved section at Johnston Road to the Serpentine Flats, has been let by the Provincial Minister of Public Works to the Cotton Co., Ltd., of Vancouver.

Walkerton, Ont.—Tenders closed June 7 for construction of concrete pavement in alley west of Lincoln Rd., between Sandwich and Wyandotte Streets. Town Clerk, A. E. Cock.

Welland, Ont.—Robert Cooper, M. P. P., is agitating for the construction of a county provincial highway from Welland County west to Attercliffe. Five miles west from Beckett's bridge will be constructed this year and other sections will be graded.

Windsor, N.S.—Gorman & Pickrem, of Halifax, have been awarded contract for street paving. Contract consists of re-topping Water St., paving part of Gerrish St., and part of King St., from Lynch's Corner to Curry's Corner.

Windsor, Ont.—Board of Works recommended that contract be awarded to the Cadwell Construction Co. for construction of pavement from the alley west of Janette to Dougall Ave. Wellington Ave., from Tecumseh Road to Elliott St., will be paved by the Chick Contracting Co.

Windsor, Ont.—City Council awarded contract to Pettypiece's, Ltd., of Amherstburg, Ont., for paving Randolph St. at approximately \$5,000; for paving Lot St. to S. P. West, Sandwich, at approximately \$5,000; and contracts for sidewalks on Lawrence and Wyandotte Sts. to L. J. Ryan, of Windsor.

Windsor, Ont.—With the object of boosting the pre-jection of 120-mile tourist road from Detroit to Goderich, W. G. Coutts, of Goderich, was in the Border Cities recently, conferring with several authorities who would naturally be interested in a project of this kind. Mr. Coutts' idea is to make this road a link in the Dixie Highway, which runs from New Orleans to Detroit. He states that several of the towns along the route are already committed to the project, notably Goderich, the proposed terminal. Sanla Chamber of Commerce is calling a conference for representatives of all towns along the route, at which definite plans for the road will probably be made.

Winnipeg, Man.—Contract for construction of granolithic walks awarded to Thos. Jackson & Sons, Colony St. Winnipeg.

Woodstock, Ont.—North Oxford Township Council passed a resolution which calls for the construction of an 0-ft. span bridge over the Thames River. Estimated cost, \$8,125. Clerk, Richard Seldon, Ingersoll.

Yarmouth Tp., Ont.—Township Council passed by-law providing for the construction of sidewalk on the north side of First St., west of St. George St. Clerk, W. C. Caughell. St. Thomas, Ont.

York Tp., Ont.—Township Council authorized an expenditure of \$79,371.83 for sidewalks, pavements and grading. Engineer, Frank Barber, Toronto.

York Tp., Ont.—Township Council awarded following contracts for construction of concrete sidewalks: Goyder Ave. and Greenwood Ave., J. J. Ramsay, Toronto; Mayfield Ave., National Contracting Co.; Mahoney Ave., S. Simpson; Gilbert Ave. and Mortimer Ave., A. J. Penberthy; LeRoy Ave. W. B. Hughes; Queensdale Ave. and Connor Ave., H. S. Walton; Willard Ave., P. Licastro & Co.

WATER, SEWAGE AND REFUSE

Islington, Ont.—A water supply scheme to take in the area from the west of New Toronto east to Long Branch Park, and south from the railway to the lake, at an estimated cost of \$98,000, was submitted to the Etobicoke Township Council by James, Proctor and Redfern, Ltd., Consulting Engineers, Toronto. The improvement will be put to

the vote of the people. Plans for water in the area of the northern boundary of Mimico to the Home Smith property at Lambton Mills were submitted by the Provincial Board of Health, the system to be installed at a cost of \$53,000.

Montreal, Que.—Tenders close June 14 for construction of sewer in Laverdure St., between Gouin Boulevard and 42nd Ave. City Clerk, Rene Bauset.

Montreal, Que.—Director of Public Works decided to recommend to the executive committee the laying of a 48-in. water main from the Point St. Charles Pumping Station to a point in the vicinity of the Place Viger Hotel, a distance of about two miles.

New Toronto, Ont.—Reeve Gardhouse will propose the submission of a by-law for debentures for a water works system from New Toronto to serve Long Branch and the Lake Shore Road district as far west as Etobicoke Creek, south of the Grand Trunk Railway tracks.

Niagara Falls, Ont.—Water Commissioners authorized construction of water mains on following streets: Wilmott St., from First to Fifth; McGrail, Fourth to Centre; Third Ave., Bridge to Hamilton.

Oshawa, Ont.—Board of Water Commissioners decided to grant the request of residents of Simcoe St. South, Cedar Dale Village, for a water supply from the town's mains. Commission decided to construct water mains on Ritson Road, between Eulalie and Olive Avenues.

Port Credit, Ont.—A detailed plan of the proposed water works system was submitted to the Town Council by William Storrie, of Gore Nasmith & Storrie, Consulting Engineers, Toronto. Estimated cost, \$120,000. Plans have been fully approved by Provincial Board of Health.

Riverside, Ont.—Carlotte Bros., Walkerville, secured contract for construction of cast iron water main on Clair View, Elinor and John M. Streets, and also from Ean Claire Water plant to Little River.

St. John, N. B.—A new system of sewerage for the Shamrock grounds is being considered. R. W. Wigmore, Commissioner of Water and Sewerage.

St. Thomas, Ont.—Work on the construction of the sanitary sewer under the eastern end of Malakoff St. will be started shortly, work to be done by day labor. No. 2 Committee of City Council also recommended installation of sanitary sewer under Hiauwatha St. by day labor. City Engineer, W. C. Miller.

Sarnia, Ont.—With the approval of the City Council, the water works committee accepted tenders for annual supplies as follows: Gartshore-Thomson Pipe & Foundry Co., Hamilton, 4 and 6-in. cast iron pipe at \$57 per ton; Kerr Engine Co., 4-in. valves, \$9.55, 6-in. valves, \$16.33; Mueller Mfr. Co., valve boxes, \$7.86; pig lead, \$6.25 per hundred pounds; Dominion Steel Products Co., fire hydrants, \$66 each.

Toronto, Ont.—City Council intends to construct sewers in Dawson St. at a cost of \$3,980.

Welland, Ont.—Tenders closed June 6 for construction of 252 in. ft. 10-in. sewer on Margaret St.; 68 in. ft. 8-in. sewer on Nye Ave.; and 156 in. ft. 10-in. sewer on Queen St. West. City Clerk, W. E. Forster.

Windsor, Ont.—Several sewer contracts were awarded to Carlotte Bros. by Board of Works.

Windsor, Ont.—Contracts to construct sewers and pavements were awarded to Colloff Bros., of Walkerville; the Chick Contracting Co., Windsor; and the Cudwell Co., of Windsor.

York Twp., Ont.—Township Council authorized an expenditure of \$11,982.30 for 6-in. water mains. Engineer, Frank Barber, Toronto.

LIGHT, HEAT AND POWER

Catawaqui, Ont.—A Hydro power line is to be constructed from Kingston here.

Chatham, Ont.—Farmers residing on the 10th Con. in Raleigh Township have made an application to the local Hydro System for an extension along the above concession

road. This will be done when the extensions to Fletcher and Merlin have been completed.

Cobalt, Ont.—Northern Canada Power Co. is proceeding to build another power house.

Merlin, Ont.—Engineers Lawler and Wright, of the Hydro-Electric Power Commission of Ontario, are here making preparations for the construction of the new Hydro line to Merlin.

Pembroke, Ont.—Contract for supplying materials and constructing a dam at the High Falls on Black River has been awarded to A. G. Tweedie, of Sault Ste. Marie, by the Pembroke Electric Light Co.

RAILWAYS

London, Ont.—A large American railroad system, said to be the Pennsylvania, has instructed real estate agents in London and district to proceed without delay to secure data on the cost of land for a right of way through territory between Niagara Falls and Windsor.

Montreal Division, C.N.R.—Tenders will be received until 12 o'clock noon, Saturday, June 24, for construction of six structures. (See official adv.).

Nipissing & Nipigon Divisions, C.N.R.—Tenders will be received until 12 o'clock noon, Saturday, June 24, for the construction of nine structures. (See official adv.).

Ottawa Division, C.N.R.—Tenders will be received until 12 o'clock noon, Saturday, June 24, for construction of two structures. (See official adv.).

Toronto, Ont.—City is ready to proceed with construction of Pape Ave. car line.

FACTORIES AND LARGE BUILDINGS

Ailsa Craig, Ont.—Following tenders were received by Ailsa Craig Farmers' Co-operative Association for construction of concrete grain tanks and warehouse: Jos. Lawson, Crediton; E. Barnes, Ailsa Craig; A. K. Stewart, Parkhill; Ezra & Mazifer, Milverton; T. H. Chambers, Woodstock. Contracts not yet awarded.

Barrie, Ont.—Fire damaged the business section to the extent of about \$50,000.

Birch Cliff, Ont.—General contract for four-roomed addition to Birch Cliff Public School, S.S. No. 15, was awarded to Norman McLeod, Ltd., at approximately \$37,500. Burden, Gouinlock & Carter, Toronto, Associate Architects.

Bonne Bay, Nfld.—The business section was swept by fire which caused a loss of \$250,000.

Brantford, Ont.—Tenders will be received until June 14 for construction of Terrace Hill School. Architect, F. C. Bodley, Commercial Chambers, Brantford.

Burnaby, B.C.—Tenders closed June 9 for erection of a High School building on the Kingsway school site. Architects, McCarter & Nairne, 509 Richards St.

Calgary, Alta.—General contract for four-roomed addition to St. Anne's School, East Calgary, was awarded to C. W. Pettifer, 1018 9th Ave. West, for \$15,668; plumbing and heating, Young Plumbing Co., 1st St. East, \$3,290.

Charlottetown, P.E.I.—Tenders addressed to Rev. J. Rooney, Secretary, will be received until June 15 for construction of Charlottetown Hospital. Plans and specifications may be seen at office of C. B. Chappell & Hunter, Architects, Charlottetown.

Creston, B.C.—Board of Education considering extensions to High School.

Crowland Twp., Ont.—Township Council passed a by-law providing for the raising of \$32,000 for the construction of a four-room addition to Maple Leaf Park School. Clerk, Wallace Houthy, Welland.

Edmonton, Alta.—Ratepayers passed library and school by-laws. City Clerk, C. E. K. Cox.

Edmonton, Alta.—Fire destroyed the Mercer Block, a four-storey building on 104th St., causing an approximate loss of \$100,000.

Edmonton, Alta.—Hudson's Bay Co. plans the erection of a large warehouse between 106th and 107th Sts., at an approximate cost of \$60,000.

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Engineering Profession Act, Province of Ontario

Complete Text of Act as Finally Passed by Provincial Legislature and Signed by Lieutenant-Governor—Engineers Accept Act Despite Numerous Changes, and Will Proceed With Registration of Professional Engineers

HAVING received the signature of the Lieutenant-Governor of Ontario on June 13, the "Act Respecting Professional Engineers" is now on the statute books of that province. The bill was introduced as No. 67 by Col. A. W. Gray, M.P.P., the only professional engineer who is at present a member of the Ontario Legislature. It received in its first reading on April 6, 1921; second reading, April 20, 1921; third reading, June 5, 1922, the previous session having been prorogued without giving the bill its final reading.

Numerous changes were made in the bill every time it was considered by the House or in Committee, and several sections that were in the original draft have been deleted, while others have been altered. It has been decided, however, by the Legislation Committee, of the various engineering societies to accept the Act as passed and to go ahead with the formation of the "Association of Professional Engineers of the Province of Ontario."

General C. H. Mitchell, dean of the Faculty of Applied Science of the University of Toronto, who is president of the provisional council of the association, is in British Columbia, and no meeting of the council will be held until his return to Toronto. The vice-president of the provisional council is R. A. Bryce, consulting mining engineer, Toronto. The provisional councillors are Willis Chipman, consulting civil engineer, Toronto; J. B. Challies,

Director of Water Powers, Ottawa; Col. A. W. Gray, M.P.P., of Westport, Ont.; H. G. Acres, chief hydraulic engineer of the Ontario Hydro-Electric Power Commission, Toronto; H. H. Angus, consulting mechanical engineer, Toronto; A. K. Spotton, chief engineer, Goldie & McCulloch Co., Ltd., Galt, Ont.; Prof. J. W. Bain, associate professor of applied chemistry, University of Toronto; S. F. Kirkpatrick, consulting chemical engineer, Ottawa, Ont.; Harold Van der Linde, vice-president of the Van der Linde Rubber Corporation, Toronto; H. V. Hart, general manager and chief engineer, Canadian Westinghouse Co., Ltd., Toronto; F. R. Ewart, consulting electrical engineer, Toronto; M. J. McHenry, manager, Walkerville Hydro-Electric System, Walkerville, Ont.; G. R. Mickle, mine assessor, Parliament Buildings, Toronto; Prof. H. E. T. Haultain, professor of mining engineering, University of Toronto; James McEvoy, consulting mining engineer and geologist, Toronto.

Following is the complete text of the Act as signed by the Lieutenant-Governor:

An Act respecting Professional Engineers.

His Majesty, by and with the advice and consent of the Legislative Assembly of the Province of Ontario, enacts as follows:

1. This Act may be cited as The Professional Engineers' Act, 1922.

2. In this Act (a) "Association" shall mean the As-



Willis Chipman



J. B. Challies



Col. A. W. Gray

CIVIL ENGINEERING REPRESENTATIVES ON THE FIRST COUNCIL OF THE ASSOCIATION OF PROFESSIONAL ENGINEERS ONTARIO

sociation of Professional Engineers of the Province of Ontario; (b) "Board" shall mean the Board of Examiners of the Association; (c) "Council" shall mean the Council of the Association; (d) "Licensed" shall mean that permission has been granted by the council to a non-resident engineer to practise temporarily without being registered, and "License" shall mean the official certificate under the seal of the Association evidencing such permission; (e) "Member" shall mean a Registered Member of the Association; (f) "President" shall mean the President of the Association; (g) "Professional Engineering" save as herein-after mentioned, shall mean the advising on, the reporting on, the designing of, the supervising of the construction of, all public utilities, industrial works, railways, tramways,



Robert A. Bryce
VICE-PRESIDENT, COUNCIL, PRO-
FESSIONAL ENGINEERS OF
ONTARIO

bridges, tunnels, highways, roads, canals, harbour works, light houses, river improvements, wet docks, dry docks, floating docks, dredges, cranes, drainage works, irrigation works, waterworks, water purification plants, sewerage works, sewage disposal works, incinerators, hydraulic works, power transmission, steel, concrete and reinforced concrete structures, electric lighting systems, electric power plants, electric machinery, electric apparatus, telephone systems, telegraph systems, cables, wireless plants, mineral property, mining machinery, mining development, mining operations, gas and oil developments, smelters, refineries, metallurgical machinery, and equipment and apparatus for carrying out such operations, machinery, steam engines, hydraulic turbines, pumps, internal combustion engines and other mechanical structures, chemical and metallurgical machinery, apparatus and processes, aeroplanes, air ships, and all other engineering works; (h) "Registered" shall mean that an engineer has been admitted to membership in the Association and that his name has been enrolled in the register; and "Certificate of Registration" shall mean the official certificate under the seal of the Association evidencing the same; (i) "Registrar" shall mean the Registrar of the Association; (j) "Secretary" shall mean the Secretary or the Secretary-Treasurer of the Association; (k) "Vice-President" shall mean the Vice-President of the Association.

3.—(1) All persons registered as professional engineers under the provisions of this Act shall constitute the "Association of Professional Engineers of the Province of

Ontario" and shall be a body politic and corporate, with perpetual succession and a common seal.

(2) The head office of the Association shall be at the City of Toronto.

(3) The Association shall have power to acquire and hold real or personal property not producing at any time an annual income in excess of \$10,000, and to alienate, mortgage, lease, or otherwise dispose of such property or any part thereof as occasion may require.

(4) All fees, fines and penalties receivable and recoverable under this Act shall belong to the Association.

4. The Association may pass by-laws not inconsistent with the provisions of this Act for:

(a) The election of "council"; (b) The government and discipline of the members; (c) the management of its property; (d) the appointment of such officers as may be necessary for carrying out the purposes of the Association; (e) the maintenance of the Association by fixing, levying and collecting the necessary fee from each member and licensee, which fee shall not exceed \$10 per annum; (f) the admission of candidates to registration; (g) the keeping of the "register"; (h) fixing dates and places of meetings of the "Association"; (i) all such other purposes as may be deemed necessary or convenient for the management of the association, or the conduct of its business.

5. No by-law of the association or amendment thereto shall be valid or take effect until approved by the Lieutenant-Governor in Council.

6.—(1) For purposes of representation upon the council and for registration, and for such purposes only as are hereinafter set out, membership of the association shall be subdivided into the following branches: Civil engineers, mechanical engineers, chemical engineers, electrical engineers, mining engineers.

(2) Each member admitted to the association may register in all branches for which he can submit credentials satisfactory to the authority governing admission to each of such branches, but he shall, however, vote in only one such branch according to his own selection, but may transfer his vote to some other branch in which he is registered, upon the approval of the council.

7. Additional branches may be established by the Lieutenant-Governor in Council upon the petition of not less than 100 registered members of the association, provided such petition be approved by the council, or upon petition of 200 members of the association if such approval be not obtained.

8.—(1) The council shall consist of a president, a vice-president, an immediate past-president and three councillors from each branch of the association, all of whom shall be registered members of the association.

(2) The president, who shall be elected annually by vote of members, shall hold office until his successor is elected, shall act as presiding officer at the meetings of the council and of the association, voting only when the votes are evenly divided, and on his retirement shall hold office as councillor for the next year succeeding.

(3) The vice-president shall be elected annually by vote of members, and shall have all the powers of the president during the absence of the latter.

(4) Two councillors shall be elected annually from each branch of the association by the vote of the registered members in such branch, and one councillor from each branch shall be appointed by the Lieutenant-Governor in Council.

(5) The council shall appoint a registrar and a secretary who shall hold office during the pleasure of the council.

9.—(1) The members of the council representing each branch shall control, subject to the terms of this Act, the conditions for registration and for licensing in such branch, including credentials, examinations and exemptions.

(2) The council as a whole shall have the power to review the establishment of and the carrying out of the conditions for registration as administered by the representative councillors from all branches, and shall have the power to require the representatives of such branches to modify

their administration in order to maintain a standard of qualification in members satisfactory to the council.

(3) The revocation of certificates and the reissuing of such certificates, the questions of discipline, fines, suspensions, expulsion, finance, overlapping of practice in branches, and all matters not coming within the provisions of subsection (1) shall be dealt with by the council as a whole.

Registration Within One Year

10.—(1) Any person residing in the Province of Ontario at the date of the passing of this Act, who has been engaged in engineering for five or more years, shall be entitled to be duly registered as a member of the association without examination, provided that such person shall produce to the council, within one year of the passing of this Act, satisfactory evidence of having been so engaged.

(2) Any person residing in the Province of Ontario, not qualified as in subsection (1) above, may make application for membership in the association and shall successfully pass such examination as shall be prescribed by council, or submit credentials satisfactory to the council, to be admitted to membership.

(3) Any person who applies for membership in the association within one year from the passing of this Act shall submit to the council with his application a statement giving a summary of his engineering experience, which statement shall be made upon the forms prescribed by the council.

(4) The council may require the applicant for membership to prove the correctness of the statements made in his application by attesting by oath or by affidavit.

(5) If the evidence of employment as engineer for five years, as submitted by the applicant, be considered satisfactory by the members of the council representing the branch to which admission is desired, he shall be admitted to membership in the association without examination and the registrar shall issue a certificate of registration to applicant and enter his name in the register.

(6) Any person duly authorized and registered as an Ontario land surveyor at the date of the passing of this Act shall be entitled on application within one year of the passing of this Act, to be admitted as a member of the association in the branch of civil engineers.

11. If the applicant for membership has been engaged for less than five years as a professional engineer at the date of the passing of this Act, he shall submit certificates and proofs respecting the period of his employment to the date of his application, and the members of council, representing the branch to which admission is desired, will determine from the evidence so submitted the period of such employment.

Registration After One Year

12. Any person resident in the Province of Ontario who has applied for membership in the association within one year from the passing of this Act, who has not been admitted under the provisions of section 10, shall file with the secretary a notice setting forth his employment and the name of his employer, which notice shall be filed annually during the term necessary to complete the five years of employment, and if such person's record of employment is satisfactory, he shall be admitted to membership without examination.

13.—(1) Any person who applies for membership in the association after one year from the passing of this Act shall submit to the council with his application a statement giving a summary of his experience as an engineer or surveyor which statement shall be made upon the forms prescribed by the council.

(2) The council may require the applicant for membership to prove the correctness of the statement made with his application by attesting by oath or by affidavit.

(3) If the evidence of engineering experience for not less than five years, as submitted by the applicant, is considered satisfactory by members of council representing the branch to which admission is desired, the applicant shall be admitted to membership after successfully passing the pre-

scribed examination in the theory and practice of such branch of engineering or, in lieu of such examination, upon submission of evidence satisfactory to the members of council representing such branch and to the council as a whole.

(4) An applicant who is required to successfully pass an examination may select any one or more branches of engineering for his examination.

14. Any resident of Canada who may come to reside in the Province of Ontario and who at the time is a duly registered member of an association of professional engineers in any province of the Dominion of Canada similarly constituted to this association, may upon application made



Brig.-Gen. C. H. Mitchell
PRESIDENT OF THE COUNCIL
PROFESSIONAL ENGINEERS
OF ONTARIO

to council be admitted to membership upon producing a certificate of membership in such province.

15. Any person who comes to reside in Ontario who is a registered member of any association or institute in other parts of the British Empire or in the United States similarly constituted to this association, and which grants reciprocal privileges and who applies for membership in this association, may be admitted to membership upon producing to council a certificate of membership in such association or institute.

Graduates

16.—(1) Any graduate in any branch of engineering or of science, the practice of which constitutes professional engineering as defined in clause (g) of section 2, from any university recognized by the council upon presenting evidence of graduation satisfactory to the council will be granted, as part of his term of employment, the actual time of instruction in such university, this total not to exceed four years and such graduate will not be required to submit to a written examination.

(2) Graduates or undergraduates of recognized engineering colleges or bona fide assistants serving under articles may during the remainder of their respective periods required for registration be engaged in professional engineering as defined in this Act under the guidance of professional engineers who assume full responsibility for their work, but shall not be classed as professional engineers until registered as members of the association as provided in this Act.

(3) Such graduates, undergraduates, or assistants serv-

ing under articles may, during their respective engineering courses or terms of service, be recorded with the association, and such graduates, undergraduates, or assistants serving under articles shall be subjected to the control of the council as provided in this Act and to the by-laws of the association, but shall not be members of the association.

Licensing

17.—(1) Any person not residing in the Province of Ontario who is a registered member of an association of engineers similarly constituted of any other province of the Dominion of Canada may upon application obtain from the registrar a license to practice as a professional engineer in the Province of Ontario upon production of evidence of his registry in such other province.

(2) Any person who is not a resident of Canada, but who in the opinion of the members of council in any branch is recognized as a consulting specialist in such branch of engineering, and has had not less than ten years of experience in the practice of his profession, or who presents evidence to satisfy such members of council that he has equal qualifications with those required for registration in such branch of the profession, may, with the approval of the members of council of such branch, be granted a license to practice in that branch.

(3) Any professional engineer who is a resident of some other province of Canada in which there is no association of engineers similarly constituted may obtain a license to practice in a branch of engineering, subject to the approval of the members of council representing such branch.

(4) In the event of any such person mentioned in this section being unable by reason of emergency or neglect on the part of the registrar, or for any other good and sufficient reason, to obtain such license within three months of his making application therefor, he shall be entitled to practice as a professional engineer in the province for such period of three months without holding such license.

18. Any person who is employed as a professional engineer by a public service corporation, public utilities or Government department, who is by reason of his employment required to practise as a professional engineer in provinces other than that of his residence, may so practise, in the Province of Ontario without holding a non-resident license or payment of fee, providing such person can on demand of the council produce credentials satisfactory to the council showing that he is a registered member of an association of engineers similarly constituted by some other province of Canada.

Membership

19.—(1) Only such persons who are members of the association hereby incorporated, and registered as such under the provisions of this Act, or who have received a license from the council of the association as hereafter provided, shall be entitled within the Province of Ontario to take and use the title "Registered Professional Engineer," or any abbreviation thereof.

(2) Each member of the association shall have a seal, the impression of which shall contain the name of the engineer and the words "Registered Professional Engineer" and "Province of Ontario," with which seal he shall stamp all official documents and plans, and the design of such seal shall be approved by the council.

20. The provisions of this Act shall not apply against any person while carrying on his duties in His Majesty's naval, military or aerial service.

21. Engineers who were employed in professional engineering in the Province of Ontario, and who were accepted for overseas service in the war of 1914-1919, in the forces of Great Britain or any of her allies, shall on their return to Canada be entitled to all the rights and privileges conferred under section 10.

22. Notwithstanding any other provision of this Act; no person shall be registered as a member of the association until after he has attained the age of twenty-one years.

23.—(1) In the case of two or more persons carrying on a practice as professional engineers in co-partnership,

only such members who are registered or licensed under this Act shall individually assume the function of a professional engineer.

(2) A firm or corporation of professional engineers cannot, as such, be deemed to be a member of the association or be licensed to practise.

Examinations

24. The council shall appoint annually a board of examiners for each branch of engineering from nominations made by members of council representing each of such branches.

25.—(1) Examinations of candidates for registration or for license shall be held at least once per annum, at such place as the council may direct.

(2) The scope of the examinations and the methods of procedure shall be prescribed for each branch by the members of council representing such branch, with special reference to the applicant's ability to design and supervise engineering works which shall insure the safety of life and property.

(3) The board shall examine all degrees, diplomas, certificates and other credentials presented or given in evidence for the purpose of obtaining registration or license to practise, if referred to them by the council, and may require the holder of such degree, diploma, certificate or other credentials to attest on oath, viva voce or by affidavit concerning the matter of his application.

(4) The candidate shall submit to an examination before the board, or before such members of the board as may be deputed by the council to conduct such examination, on such branch or branches of professional engineering as the candidate may select.

(5) As soon as possible after the close of each examination the members of the board who shall have conducted such examination shall make and file with the secretary a certificate stating the result of such examination, whereupon the council shall notify each candidate of the result of his examination and of their decision upon his application.

(6) A candidate failing on examination may after an interval of not less than nine months be examined again.

(7) The council shall from time to time prescribe the fees payable by candidates for examination, which fees shall be payable in advance by the candidates.

26. The council shall have power to establish conjointly with any council of any association similarly constituted in one or more of the provinces of Canada a central examining board, and to delegate to such central examining board all or any of the powers possessed by the said council respecting the examinations of candidates for admission to practise, provided that any examination conducted by such central examining board shall be held at least in one place within this province.

Registrar and Registrar

27.—(1) The registrar shall issue a certificate of membership to each member admitted to the association by the council, such certificate to be signed by the president or the vice-president and by the registrar, and it shall bear the seal of the association, and shall also state the branch or branches of engineering in which the member was examined or otherwise accepted.

(2) The registrar shall issue a license to practise to any person entitled thereto, such license to specify the work upon which the holder of the license is to be employed and the period for which the same is issued, but in no case shall the period extend beyond the end of the calendar year in which such license was issued.

(3) The registrar shall enroll in the register provided by the council the names of all persons admitted to the association by the council, also the names of all persons licensed by the council.

28. The registrar shall keep the register correct and in accordance with the provisions of this Act and the instructions of the council.

29. The annual fee due from a member shall be deemed to be a debt due the association and may be recoverable with the costs of same from such member in the name

of the council or of the association in any court of competent jurisdiction.

30.—(1) If any member neglects or refuses to pay the annual fee for six months from the date upon which it became due after written notice from the secretary to the member's last known address on the register, the registrar shall cause the name of such member to be erased from the register, and such person shall thereupon cease to be a member, but such person shall at any time thereafter, upon payment of such fees as may be prescribed by the council, be entitled to reinstatement as a member.

(2) Any member may resign from membership in the association upon giving written notice to the secretary and by payment of all dues in arrears, if any, whereupon the name of such member shall be erased from the register and such member shall be relieved of the liability for further annual dues, but such person shall at any time in the future be admitted as a member upon payment of the fees prescribed by the council.

(3) Any member whose name has been erased from the register shall not be entitled to any of the rights and privileges conferred by the provisions of this Act until he has been re-admitted as a member.

31. In case the council should refuse to register any applicant for membership in the association, or refuse to issue a license to practise to any applicant, therefor, the person aggrieved shall have the right to apply to a judge of the Supreme Court of Ontario, who upon due cause the name of such person as a member of the association, or shown may make an order directing the council to register to grant a license to practise, or make such other order as may be warranted by the facts, and the council shall forthwith comply with such order and such order when so made shall be final.

32. The certificate of registration under the seal of the association shall be prima facie evidence of registration.

33.—(1) The council may, in its discretion, reprimand or censure or suspend or expel any member guilty of unprofessional conduct, or of gross negligence or of continued breach of the by-laws of the association, or any member convicted of a serious criminal offence by a court of competent jurisdiction.

(2) The council shall not take any such action until after a complaint under oath has been filed with the secretary or the registrar, and a copy forwarded to the member accused, who shall be given an opportunity of submitting evidence in his defence, and the council shall not suspend nor expel a member without having previously summoned him to appear before the council, nor without having heard evidence under oath offered in support of the complaint and in behalf of the member accused.

(3) The council shall have the same powers as Commissioners under The Public Enquiries Act to compel witnesses to appear and give evidence under oath in the manner and under penalties prescribed by such court, and all such evidence shall be taken in writing or by a duly qualified stenographer.

(4) Any member suspended or expelled may within sixty days after the order of suspension or expulsion appeal to a judge of the Supreme Court of Ontario from such order or resolution, giving not less than seven days' notice of such appeal to the secretary of the association, and the practice and procedure in such an appeal shall be the same as upon an appeal from a master or referee.

(5) Pending an appeal, the member suspended or expelled by council may continue to practise, but unless the order of suspension or of expulsion be set aside, the member so suspended or expelled shall not practise thereafter except upon the expiry of the period of suspension (in case of suspension.)

34. Any person in the Province of Ontario who, not being registered as a member of the Association in the Province of Ontario, or licensed by the association, (a) uses verbally or otherwise the title of professional engineer, or makes use of any addition to or abbreviation of such title, or of any words, name or designation that will lead to the belief that he is a professional engineer or a member of the

association; (b) advertises or holds himself out in any way or by any means as a member of the association, shall be liable upon summary conviction by any court of competent jurisdiction to a fine of not less than \$100 nor more than \$200 for the first offence, and to a fine of not less than \$200 nor more than \$500 for any subsequent offence.

35. If the registrar makes or causes to be made wilful falsification of the register, or in matters connected therewith, he shall upon conviction be liable to a fine of not less than \$100.

36. Any person who wilfully procures or attempts to procure for himself registration as member in the association by making, producing or causing to be made or produced any fraudulent representation or declaration, either verbal or written, and any person knowingly aiding and assisting him therein, shall upon conviction be liable to a fine of not less than \$200.

37. Any and all penalties imposed under this Act, and any and all moneys forfeited shall be recoverable with costs under the provisions of The Ontario Summary Convictions Act, and all such sums shall belong to the association.

38. No proceedings shall be commenced for any violation against the provisions of this Act after one year from the date of the committal of such violation.

Provisional Council

39.—(1) The following persons are hereby constituted as a provisional council of the association:

President—Charles Hamilton Mitchell, of Toronto.
Vice-president—Robert Alexander Bryce, of Toronto.
Councillors—Representing branch of Civil Engineers—Willis Chipman, of Toronto; John Bow Challies, of Ottawa; Andrew Wellington Gray, of Westport. Representing branch of Mechanical Engineers—Henry G. Acres, of Toronto; Harry Holborn Angus, of Toronto; Arthur Knowlton Spotton, of Galt. Representing branch of Chemical Engineers—James Watson Bain, of Toronto; Stafford Frederick Kirkpatrick, of Ottawa; Harold Van der Linde, of Toronto. Representing branch of Electrical Engineers—Henry U. Hart, of Hamilton; Frank Richard Ewart, of Toronto; Morris James McHenry, of Walkerville. Representing branch of Mining Engineers—George Reginald Mickle, of Toronto; H. E. T. Haultain, of Toronto; James McEvoy, Toronto. All of whom shall hold office until their successors have been elected and appointed.

(2) If a vacancy should occur in the Provisional Council it shall be filled by the Lieutenant-Governor in Council, who shall notify each member of the Provisional Council of such appointment.

40.—(1) The Provisional Council shall provide the register called for by this Act, and shall cause to be entered therein the names of all persons who are entitled to registration and who apply therefor.

(2) The Provisional Council shall, within four months from the passing of this Act, prepare provisional by-laws not inconsistent with the Act for the various purposes specified in section 4 of this Act, which shall not be valid until approved by the Lieutenant-Governor in Council.

(3) The Provisional Council shall publish a copy of the register within five months from the passage of this Act, and shall mail one copy of such register to each member, and to any person who may apply for a copy, and the Lieutenant-Governor in Council shall also be furnished with a certified copy of the register and of the provisional by-laws.

(4) The Provisional Council shall call a general meeting of the members of the association for the purpose of electing the members of council, for confirmation or revision of by-laws, and for organization purposes, and for such other purposes as specified in the notice calling the meeting, such general meetings to be held not later than seven months, nor earlier than five months after this Act comes into force.

41. No provisions of this Act imposing penalties shall take effect until one year after the coming into force of this Act.

42. This Act shall come into force and take effect on the day upon which it receives the Royal Assent.

HYDRAULIC TURBINES*

Some of the Principles Controlling Their Use and Design—
Reaction Turbines — Runners and
Draft Tubes

By Lewis F. Moody,

Consulting Engineer, William Cramp & Sons Ship & Engine Building Co., Philadelphia, Pa.

BEFORE going into the hydraulic principles governing the action of hydraulic turbines, it will be well to be sure that we understand the two general classifications of turbines and the line of separation between them. We are confronted at the start with the two terms used to distinguish these two classes, and these terms are probably responsible for many misconceptions. The terms themselves do not distinguish and have little meaning.

Impulse turbines are those in which the water under pressure is discharged through nozzles or orifices and its potential energy converted into the kinetic form, so that the water issues with all of its head converted into the velocity form at atmospheric pressure, or pressure substantially atmospheric. The water, in the form of a free jet, or jets, acts against one surface of a series of open buckets mounted on a revolving element, and the action of the water in passing through this wheel takes place entirely at constant pressure, this whole action being open to the air.

In the so-called reaction turbine, on the other hand, the entire operation takes place in a closed system of passages, the water being everywhere under pressures different from that of the atmosphere, and the flow not being open to the air.

In the modern reaction turbine, the water is discharged through a ring of guide vanes which give it a rotary or whirling motion about the turbine axis, its initial potential energy being converted only in part into the kinetic form, a considerable portion still remaining as pressure head. The water is then passed through a rotating runner in which the energy is abstracted from the water, the water discharging into a closed draft tube at a pressure usually considerably less than atmospheric, and with a considerable amount of

having a series of rotating arms discharging the water in backwardly directed jets. The latter device, known as "Barker's Mill," which somewhat resembles a lawn-sprinkler, is a true reaction turbine in the sense originally intended. It is interesting to note that neither the modern impulse turbine nor reaction turbine operates on the prin-

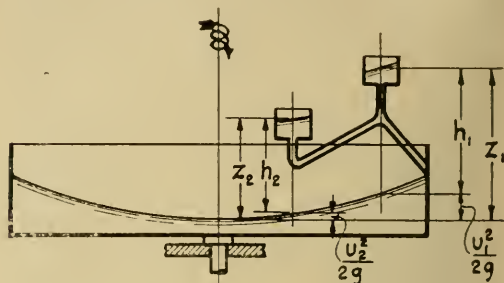


FIG. 2

ciples of the primitive wheels just mentioned. It is worth noting that the high-speed reaction turbine of today actually discharges the water from the runner in the same direction as the motion of the runner, so that its reaction, in the sense used originally, is in the opposite direction to the rotation of the wheel, tending to oppose its motion. Furthermore, both turbines are dependent upon the impulse of the entering water to produce the driving torque. In the following discussion of principles, I shall direct my attention chiefly to the reaction turbine.

Most engineers are thoroughly familiar with the theory of the turbine, but hydraulics is a subject so liable to misconceptions that I think it may be useful to touch briefly a few of the high spots of this particular branch. In approaching any hydraulic problem there are two possible plans of attack, both of which are worth keeping in mind:

The first is to establish energy relations; that is, to find out what becomes of the energy involved. The second is to establish the conditions of equilibrium under the forces of impulse and reaction; that is, to depend on the principle of momentum of the moving water.

The first method makes use of the Bernoulli formula, and the second utilizes the fact that a flowing stream or jet exerts in the opposite direction to its motion a reaction equal to $W V/g$, where W is the weight of water discharged per second, V the velocity in feet per second, and g the acceleration of gravity. If a jet be discharged into a tank so that its velocity be destroyed, or if it impinge on a plate so that no velocity remains in the original direction, it exerts a forward impulse of the same amount.

Applying the first method, we can write the Bernoulli formula for the stationary parts of the turbine system, or any other system for that matter, as follows (See Fig. 1):

$$\text{From intake to entrance to runner,} \\ h_a + H_1 - L_1 = h_{p1} + C_1^2/2g \quad \dots \dots \dots (1)$$

$$\text{From discharge from runner to tailwater,} \\ h_{p2} + C_2^2/2g + H_2 - L_2 = h_a + C_3^2/2g \quad \dots \dots (2)$$

Where h_a = Head corresponding to atmospheric pressure.

h_{p1} = Absolute pressure head at runner entrance.

h_{p2} = Absolute pressure head at runner discharge.

L_1 = Loss of head from intake to runner entrance.

L_2 = Loss of head in runner.

L_3 = Loss of head in draft tube.

C_1 = Absolute velocity of flow into runner.

C_2 = Absolute velocity of flow out of runner.

C_3 = Absolute velocity of flow out of draft tube.

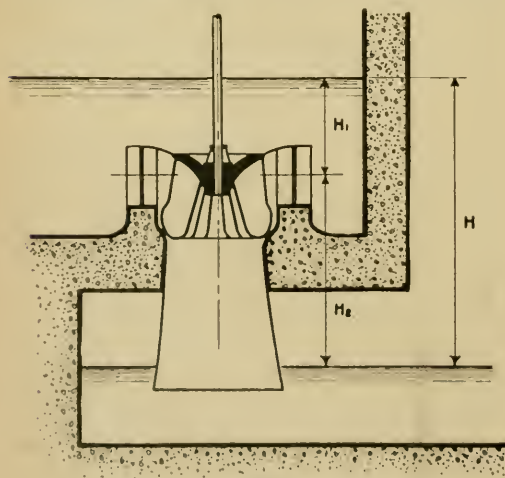


FIG. 1

kinetic energy or velocity head still remaining in the water.

The above names used to classify turbines perhaps originated in the one case in wheels in which a jet impinged on a series of flat paddles, and in the other case in wheels

*Address at the Symposium on Water Power Development, University of Toronto, February 27, 1922.

In writing the equation from entrance to discharge of runner, it must be remembered that in the runner a portion of the available energy is converted into useful work. A term must therefore be subtracted from the initial energy to leave the energy remaining at the runner discharge. The energy converted into useful work per second is WH_e , where H is the total effective head available for the turbine and e the turbine efficiency. Since in this equation we are talking about head, and since head is the energy per pound of water, the amount of head converted into useful work is He . We therefore have.

$$h_{p1} + (C_1^2/2g) - He - L_2 = h_{p2} + C_2^2/2g \dots\dots\dots (3)$$

Or, from (1) and (2), we can find the effective head on the runner by taking the difference between the sum of pressure and velocity heads at entrance, and that at discharge, also subtracting the loss of head in the runner, thus:

$$[h_{p1} + C_1^2/2g] - [h_{p2} + (C_2^2/2g)] - L_2 = H_1 + H_2 - L_1 - L_2 - L_3 = (C_2^2/2g).$$

The second term is evidently H - (total loss of head), which is equal to He , and substituting this and transposing, we again have equation (3).

The above relations may appear to be so elementary that they are hardly worth stating; and yet they have not always been observed. In particular, many turbines have been located at a height H_1 above tail water, which requires in equation (2) an absolute pressure h_{p1} amounting to less than zero.

Let us now go a step further and apply the Bernoulli formula with reference to the rotating system of the runner. The method of determining the flow in a rotating system may be explained in a simple manner. Suppose we have to consider two tanks on a merry-go-round at different distances from the axis of rotation and at different elevations. How shall we determine the flow through a connecting pipe:

If the system be stationary, it is quite easy to do this by applying the Bernoulli formula between one tank and the other, just as was done above for the turbine intake.

If the system be rotating, however, let us imagine first that we have a single large tank located below the two tanks to be investigated. (See Fig. 2).

The water surface in the large tank will take up the form of a paraboloid of revolution; and the difference of elevation at any two points in the surface, such as those just below the two tanks of the problem, is equal to the difference of the velocity heads corresponding to the rotation of

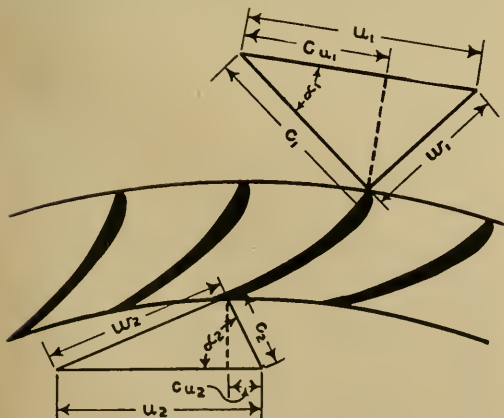


FIG. 3

the tank; that is, of the system. This difference of elevation is $u_1^2/2g - u_2^2/2g$.

Any particle in the water surface is in equilibrium and has no tendency to move either one way or the other. It is the amount of elevation above this surface which determines the head available to produce flow. Therefore, to apply

the Bernoulli formula to such a rotating system, it is only necessary to measure all elevations above a paraboloidal surface corresponding to the speed of rotation. This surface becomes a datum surface, taking the place of a plane horizontal surface in stationary problems. Thus we have for the above problem:

Head producing flow

$$= h_1 - h_2 = z_1 - (u_1^2/2g) - z_2 + (u_2^2/2g).$$

The effective head at any point of a rotating system is the sum of the pressure head, the velocity head due to the

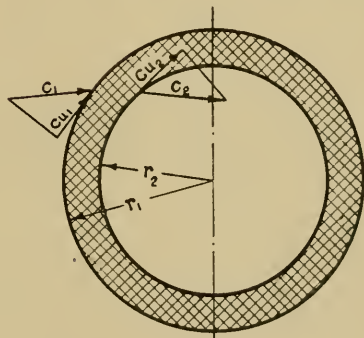
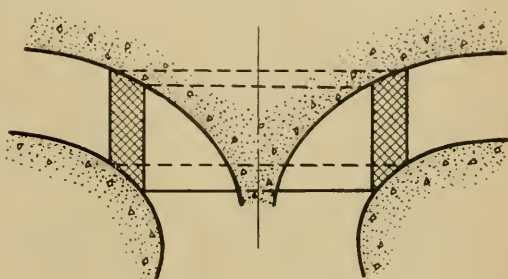


FIG. 4

relative velocity, and the elevation head above the paraboloidal datum surface.

Applying this principle to the turbine runner from the point of entrance to the point of discharge, we therefore have

$$h_{p1} + w_1^2/2g - u_1^2/2g - L_2 = h_{p2} + w_2^2/2g - u_2^2/2g \dots\dots (4)$$

We can now obtain from either (3) or (4) an expression for the pressure drop through the runner, and equating the two expressions thus found, we have:

$$h_{p1} - h_{p2} = He - C_1^2/2g + C_2^2/2g + L_2 = u_1^2/2g - u_2^2/2g - w_1^2/2g + w_2^2/2g + L_2$$

From which we obtain:

$$He = (C_1^2 - w_1^2 + u_1^2)/2g - (C_2^2 - w_2^2 + u_2^2)/2g \dots\dots (5)$$

Drawing the triangles at entrance and discharge from the runner to represent the relation between the relative and absolute velocities at these points, we have Fig. 3. Here C_1 and C_2 represent the absolute velocity of flow, and w_1 and w_2 the velocity considered relatively to the rotating system; u_1 and u_2 being the corresponding velocities of points on the rotating system itself, that is, the circumferential velocities at the points of entrance and discharge of the runner. These relations between the relative and absolute velocities can be expressed trigonometrically as follows:

$$w_1^2 = C_1^2 + u_1^2 - 2 u_1 C_1 \cos \alpha_1 \\ w_2^2 = C_2^2 + u_2^2 - 2 u_2 C_2 \cos \alpha_2$$

If we denote by C_{u1} , the tangential component $C_1 \cos \alpha_1$, of the absolute entrance velocity, which we may refer to as

the absolute entrance whirl, and similarly, if we put C_{u2} for the absolute discharge whirl $C_2 \cos \alpha_2$, we shall have

$$C_1^2 - w_1^2 + u_1^2 = 2 u_1 C_{u1}$$

$$\text{and } C_2^2 - w_2^2 + u_2^2 = 2 u_2 C_{u2}$$

By substitution of these values, (5) reduces to the simple relation

$$u_1 C_{u1} - u_2 C_{u2} = g H e \dots\dots\dots (6)$$

This equation is a fundamental one and forms a reliable basis for the design of a turbine. In the design of turbines

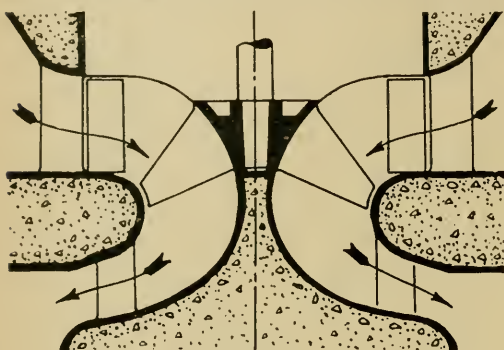


FIG. 5

of low specific speed C_{u2} may be taken as close to zero, and the second term may then be dropped. For the attainment of very high speeds, the second term may be given a considerable value in comparison with the first term. The turbine shown somewhat diagrammatically in Fig. 5 utilizes this principle.

If we approach the analysis of a turbine by the second method mentioned, we can proceed as follows:

Referring to Fig. 4, suppose we have a space bounded by surfaces of revolution swept up by rotating curves of any desired form about the axis, and let us suppose this space to be filled with water flowing inward around the periphery and outward at the bottom, this water at the same time being given an initial whirl in addition to its inward velocity. Suppose that the flow is steady; that is, the same from instant to instant, and consider the annular space marked by the double hatching. This ring is continually filled with water which is flowing in through its outer cylindrical surface of radius r_1 and out through its inner surface of radius r_2 , and at any particular point in the space the velocity, pressure and other conditions will be constant with respect to time. This ring of water is therefore in equilibrium and the forces acting upon it are balanced, and the velocity at any point has zero acceleration. The water entering the ring-formed space exerts a force in the direction of its motion equal to its weight multiplied by V/g ; and if the total weight of water entering per second around the periphery is W , the tangential component of the impulse of each elementary stream of water will be equal to the weight flowing multiplied by C_{u1}/g , and the moment exerted by all of the entering streams upon the ring of water, tending to rotate it about the axis will be equal to $W r_1 C_{u1}/g$.

Similarly, the backward reaction of the entire leaving stream will be $W r_2 C_{u2}/g$, the value of W , of course, being the same in both expressions, since the amount of water leaving is equal to that entering in accordance with continuity of flow. In such an elementary space containing no vanes, either stationary or rotating, there is no other force which can act upon the water in a circumferential direction and therefore the algebraic sum of the two turning moments must be zero, or

$$W r_1 C_{u1}/g = W r_2 C_{u2}/g = 0.$$

$$\text{Or, } r_1 C_{u1} = r_2 C_{u2} \dots\dots\dots (7)$$

This relation applies to any unobstructed space in which water may freely rotate, and can therefore be applied,

for example, to the water after it is discharged from the turbine guide vanes and before it enters the runner, and to the water in a draft tube which is bounded by surfaces of revolution co-axial with the runner.

The spiral casing for a turbine may also be so formed that the flow within it conforms to the above relation and the same thing applies to the casing of a centrifugal pump. The writer considers this to be the proper condition to observe in the design of such spiral casings, as it permits the flow to conform with the natural conditions which would exist if the spiral guiding wall were absent.

Let us now consider the conditions which we would have if the space of Fig. 4, instead of being unobstructed, contained a series of vanes. In this case, the moments of the entering and leaving water would be no longer equal and opposite, but they would differ by the amount of the moment exerted against the vanes (See Fig. 5). In this way we would obtain for the moment exerted on the turbine runner the expression

$$\text{Moment} = (W/g) (r_1 C_{u1} - r_2 C_{u2}) \dots\dots (8)$$

If we multiply this amount by the angular velocity, ω , of the runner, we shall have the work done by the runner per second, that is,

$$(W/g) (\omega r_1 C_{u1} - \omega r_2 C_{u2}) = W H e,$$

or, in terms of circumferential velocities of the runner,

$$u_1 C_{u1} - u_2 C_{u2} = g H e.$$

This result will be recognized as the same as equation (6) previously derived from energy considerations. Although derived for the modern turbine, this formula is applicable to all forms, both reaction and impulse turbines whether the flow is in a continuous ring or divided into separate jets.

These relations are, of course, not new, although there are probably many opportunities for applying them which have not been utilized. Equation (8) was announced by Leonard Euler in 1754, and the principle of equation (7) was known in the case of a vortex to Leonardo da Vinci.

More specifically, these principles when applied to a spiral casing of a turbine call for velocities at various points around the circumference which increase as the water approaches the axis, the velocity varying inversely as the radius according to equation (7). When applied to the transition space between the guide vanes and the runner, in a turbine of the type of Fig. 5, if we start with a given velocity of discharge from the guide vanes we can compute the velocity at various points along the entrance edge of the runner vane at different radial distances from the axis by multiplying the velocity in each case by the inverse ratio of the radii of the runner vane tips and guide vane tips.

When applied to a draft tube formed as a surface of revolution (Fig. 5), this principle, which is simply an application of the principle of constancy of moment of momentum, calls for a velocity which automatically decreases as the distance from the axis increases. Such a draft tube, therefore, provides an excellent means for recovering the energy of whirl with which the water leaves the runner and permits the water to discharge from the outlet of the draft tube with very little energy of whirl remaining in it.

[NOTE—In a later address Mr. Moody, by means of numerous lantern slides, showed the development of turbines from the old axial flow type of 1860, through the intermediate installations, to the latest high-speed large-capacity Queenston turbine now being installed for the Hydro-Electric Power Commission of Ontario. An interesting curve was presented which showed the total turbine capacity installed by years from 1890 to date, and also the maximum capacity developed in single turbines through the same period in the United States. The hydraulic turbine capacity in 1890 was 300,000 h.p., but at the end of 1921 it was 8,000,000 h.p. During this period the maximum unit capacity increased from 5,000 h.p. (original Niagara Falls Power Co. development) to 55,000 h.p. (the present Queenston development), the latter turbine having the largest capacity of any in the world today. A slide that caused much interesting comment was one which showed the development of progressive higher specific-speed runners. Three run-

ners were shown on the same scale of equal capacity, with specific speeds of 21.3, 80 and 153, the latter being the newly developed high specific-speed type. The contrast in dimensions was very marked. The final series of slides showed the very interesting process of turbine manufacture from the experimental work on model runners, through the foundry and shops, finally to the erection in the field. —EDITOR].

PORTLAND CEMENT CONCRETE ROADS*

Selection of Definite Highway System—Subgrade Problems and Drainage—Stresses in Pavement Slab—Eliminating Cracks in Pavements

By James Allen
Supervisor of Highways, Washington.

S ELECTION of types of pavement for our rural highways is a comparatively modern problem. Prior to 1905 there were but few rapid moving vehicles and these were confined largely to our city streets. The highways with gravel or macadam surfaces in those days were entirely adequate for the horse-drawn traffic and easily and cheaply maintained, and the paved streets of the cities cared for both classes of traffic in a satisfactory manner.

As the automobiles became more numerous and travelled farther afield, their usefulness increased and they changed from an experiment to an essential part of the world's transportation system. The tremendous increase in the automobile with its destructive forces, soon forced (those in charge of the highways to seek a surface for the highway that would be smooth, safe and economical. The business of farm and city grew to be dependent on the automobile and the highway, and the city dweller and the farmer became insistent that the highways be paved.

A new problem confronted the engineers, not many of whom realized that the conditions were much different than those surrounding the paving of a city street. It is well recognized now, however, that the character of traffic changes from comparatively slow moving vehicles evenly distributed over the width of a city street, to rapidly moving vehicles concentrated into two lines of traffic on the highway. The destructive forces set up by this high speed traffic have been studied and we are now measuring the forces that destroyed many of the earlier highway pavements; forces that all practical engineers recognize and prepare for in their designs.

Pavements were perhaps first made of concrete by the Romans who used a natural cement. The city of Edinburgh, Scotland, built a concrete pavement in the year 1872, and I understand it continues to give good service. Concrete was first used on this continent by the city of Bellefontaine, Ohio, for paving the court house square in 1892 and 1893, and the pavement is in a satisfactory condition. The year 1909 saw the first development of the Portland cement concrete pavement as a rural highway.

Selection of Routes

In order that a paving program may be a success, a definite highway system, designed to serve the majority of the people, must be selected, adhered to and built up by a continuing program covering a period of years. If the routes are not well selected, they must later be changed and the money spent on abandoned sections will serve for local purposes only. The people will get along with the poorly selected highways for a few years, but it is only a matter of time before a demand will develop for the most direct and practical route from the point of view of the motor vehicle operator. A highway must be safe, and it must serve the majority of the people. The location of a highway to secure the best route that the terrain affords, the most economical route, cost of operation and maintenance considered, is just as important as is the selection

of a route for a railway, and it deserves the same thorough study. Unnecessary distance and unnecessary grades are a direct tax on the people by reason of the increased operating costs. It is also essential that the grade be constructed and permitted to settle before a pavement is constructed thereon. Before a highway is paved in the State of Washington it must be graded and allowed to settle for at least two years. Obviously a pavement constructed on new embankments will go to pieces. While I am not giving much time to these subjects, they are, nevertheless of vital importance.

Subgrade

A pavement is a slab supported by the earth subgrade and in a broad way the four things to be considered in the structural design of the pavement slab are (1) the supporting power of the subgrade, (2) the climatic conditions, (3) the traffic that the pavement also must carry and (4) the strength of the pavement slab.

A good subgrade must be constant in volume, homogeneous in character and have a supporting power on which the design can be based. Many soils undergo a change in volume with the addition or subtraction of water, thereby changing the points of support of the pavement. If the soil increases in volume near the edge of the pavement only, the upward thrust will introduce unusual stresses in the pavement. Or if the soil, by reason of the loss of moisture, shrinks near the edge of the pavement, leaving the pavement unsupported, the wheels of traffic will break down this edge until it is supported by the soil. If a subgrade is not constant in volume, the design must provide for the change in the position of the support afforded the pavement. By a homogeneous subgrade, I mean a subgrade that is uniform in character. Soft spots or unusually hard spots are harmful. The pavement must be uniformly supported in order that the stresses may be equalized and distributed in all directions in the slab. If they are concentrated by hard or soft spots in the subgrade, the pavement must fail first at these points. A subgrade constant in volume and homogeneous in character must also have definite supporting power on which the design of the slab may be based.

There is, perhaps, no subject that has been written of and spoken of so often and neglected so much as the subject of drainage. The surface and ground waters must be removed away from a pavement if the pavement is to last. This is particularly true if the frost penetrates the ground more than 6 or 8 in. The upheaval of pavements due to frost action is a very common occurrence and one of the seriously harmful agencies to be understood and cared for. Good drainage and a thorough understanding of climatic conditions are necessarily a part of the success or failure of a pavement. Changes in the temperature of the concrete slab and changes in the moisture in the concrete develop forces that are to be provided for and worked with, rather than resisted. The natural forces as well as the forces of traffic must be studied and met in pavement design.

Character of Traffic Changes

It was little thought fifteen or twenty years ago that the volume and character of traffic on our modern highways would change so tremendously. The number and size of vehicles grew by leaps and bounds, as also did the loads that they carry. The five or seven passenger car grew to a twenty or twenty-five passenger bus; the one ton truck to the huge freight and logging truck of today. It seems, however, that this growth must be, and in fact it is, being controlled by legislation in the interest of the limit of our financial ability to construct pavements to withstand the loads. Without legislation to control the maximum sized truck and the distribution of its weight upon the pavement, it would be impossible to maintain our highways and reap the benefits to which we are entitled by reason of the public funds invested in the highways. Pavements, of course, can be built to withstand any given load, but the funds needed to pay for them, would bankrupt our people. I suggest that the load be limited to 18,000 lb. to

*Paper read at the Ninth Annual Convention of the Canadian Good Roads Association, Victoria, B.C., June 15-19, 1922.

any one axle and that the vehicle having four wheels be limited to 12 tons. In studying this subject, the causes of and the amount of impact must be known. Tests have been made along this line that have demonstrated the value of pneumatic and solid rubber tires and the much greater impact with solid rubber tires as compared with pneumatic tires. While the volume of traffic is important, its character is vital, and the loads must be thoroughly studied.

In the early days the stresses in the pavement slab were not calculated. The problem, being one of mechanics, involving a multitude of stresses acting from below as well as from above, justifies a vast amount of research work that is now being attacked in a scientific manner. The technical data developed regarding the character and impact of traffic and its effects on the pavement, the supporting power and reactions of the subgrade, the distribution and variations of the subgrade reactions and the stresses in the various parts of the pavement slab are technical and too involved to be discussed at this time. Progress in research is very rapid and, while it is improbable that we shall ever develop short formulae that will be adequate, it nevertheless will be possible to design an adequate and economical pavement after a thorough study of the subgrade, the traffic and the materials of which the pavement will be made.

Causes of Cracks

The ordinary defects found in concrete pavements are broken corners and cracks, both longitudinal and transverse. Pavements inadequate because of design, faulty materials or faulty construction as to ravel and break down completely, are not considered here for the reason that this condition can be avoided without any great difficulty. Broken corners, having a length along either leg of 2 or 3 ft. are serious and should be avoided by a proper thickness of slab. The corner of a slab or section of pavement has been demonstrated to act as a cantilever beam and can be designed as such, considering the maximum wheel load, impact, and the strength of the concrete. This calls to mind again the necessity of limiting the wheel load to a given maximum as a basis for design. A pavement designed to have sufficient corner strength to carry a certain traffic will be adequate as far as shearing or punching strength at other points is concerned. Transverse and longitudinal cracking cannot be so easily eliminated. These cracks are caused by stresses due to beam action in the slab, unequal expansion and contraction, due to moisture and temperature changes, frost action and unequal support afforded by the subgrade. The subject is being studied and the question arises as to how far we shall go in expense to avoid cracks altogether. At first a crack was thought to be a sign of incipient failure. Experience has shown, however, that from a maintenance and operating point of view, they are not fatal; it is still a matter of opinion as to how serious they are. There are many pavements eight to ten years old that are badly cracked and they continue to give good service, at a comparatively low cost for maintenance.

Sand is "just sand," and gravel "just gravel" to the average man. To the engineer, however, they are an important part of his work and must be thoroughly tested to determine their fitness for concrete construction. It is also necessary to test the cement and the water proposed for use in concrete construction. The possible sources of sand and gravel should be thoroughly examined before the contract for a pavement is awarded. The examination should include test holes to determine the quantity of materials available, and the sand and gravel should be thoroughly tested to determine their suitability or the possibility of washing and regrading to make them satisfactory. This information, if available to contractors, will eliminate the most extreme and risky gamble connected with pavement construction. It is also advisable to acquire the property for the development of side of the road pits, as the municipality is in a better position to purchase the land from which the sand and gravel are to be taken than is the contractor. If the property is made available to the

bidders by the organization awarding the contract, all bidders are on the same competitive basis; if, on the other hand, one contractor should acquire the property to the exclusion of all others, he can exploit his position for his personal profit, a condition that means increased costs of construction.

Good Workmanship Essential

Good workmanship must go hand in hand with good materials. The one is just as essential as the other to a good job. We have developed a system of carrying on and finishing our work that has eliminated the personal equation to a large extent. Each contractor is required to furnish a definite set of tools designed by the state and to use them in a certain prescribed manner. Each workman is thereby given the benefit of the experience of all by being supplied with tools and instructions from our engineers and they secure a first class job.

The specifications covering the details of materials and construction are quite thoroughly developed, and, under competent engineers, are getting good results. From a layman's point of view and from an administrative point of view, the thing to do is to secure the services of competent engineers and then to back them up. Specifications are only as good as the inspection. Furthermore, no matter how good the specifications, their value to the work is measured by the loyalty, intelligence, and judgment of the engineers and inspectors in charge of the work and the support given them by public officials and the public at large.

SASKATCHEWAN GOOD ROADS ASSOCIATION

FIRST annual meeting of the recently organized Saskatchewan Good Roads Association will be held at Regina on August 2. This was decided at a meeting of the provincial executive held recently. The preparation of the agenda and other details have been placed in the hands of a committee composed of the Hon. S. J. Latta, Mayor Grasse, L. A. Thornton, of Regina, and Sheriff Calder, Saskatoon.

I. A. Bowman was appointed secretary-treasurer and received instructions to communicate with Hon. S. J. Latta, as president of the Dominion Good Roads Association, announcing the formation of the provincial body and assuring co-operation to the common end.

The secretary, with Lieut.-Col. F. J. James, were appointed a committee to have the constitution printed and issued in pamphlet form, and another committee, composed of D. Laycock, Swift Current; Dr. W. M. D. Henderson, Regina, and Sheriff L. G. Calder, Saskatoon, was given the responsibility of drafting a form of bylaws for local branches.

MONTREAL PLANNING BOARD

A City Council, the proposed City Planning Board according to a by-law recently drafted by the Montreal will consist of five members, of whom two will be the director of departments and the director of public works; the three other members will be chosen from among the citizens of Montreal, and will be named by a resolution of the city council; these last three members of the board will be selected by reason of their knowledge of the art of embellishing cities.

The board will possess the powers conferred on it by the council of aldermen, but the powers will be limited to matters relating to the embellishment of the city.

All expense incurred by the board will be limited to the amounts placed at its disposal by the council, and the city will not be responsible for sums spent by the board exceeding the amounts voted by the council, and neither for sums spent by the board for purposes other than those for which the funds shall have been voted. The chief engineer of the city will be the engineer of the commission.

CONTROLLING QUALITY OF MATERIALS IN HIGHWAY CONSTRUCTION*

Field and Laboratory Tests—Methods of Obtaining Samples—Testing Materials for Concrete—Control of Cement Concrete—Standardizing Tests

By John H. Bateman

Director, Michigan State Highway Laboratory.

HIGHWAY construction and maintenance are affected by a great many factors, all of which are of more or less importance in the successful prosecution of work. Leaving out of consideration administration and financing, and considering the items of construction and maintenance, we may quite properly consider two factors which are necessary to attain good results, namely, good workmanship and a good quality of materials. The inspection of construction and maintenance work deals to a very large extent with these two factors and the careful inspection of both is necessary to insure good work. The necessity for this inspection may generally be considered as due to three principal causes: first, an intent on the part of the construction organization or the producers of materials to actually do poor work or furnish low-grade materials; second, carelessness on the part of the employees, and third, ignorance of the work, due to unfamiliarity or lack of training or experience. The first of these reasons is probably responsible to only a small degree for the necessity of careful inspection of materials. The latter two reasons are probably responsible in a much higher degree for the presence of a poor quality of material on any work.

Under inspection of materials we should also include the necessity or desirability of the work of controlling the proper use of these materials.

The control of quality of materials in highway construction and maintenance, as in other forms of construction and maintenance work, is of a two-fold nature involving both laboratory methods of examination and field testing. These two factors are not distinctly separate operations, but are bound together by reason of the nature of the work, and the successful control of materials depends entirely upon the proper relationship existing between a laboratory and field inspection forces.

Laboratory methods of examination in many cases are necessary because of the difference in methods of analysis of the many materials entering into the construction and maintenance of highways. In the case of many materials, proper examination consists of both laboratory and field work. A brief description of some of the more important tests of various materials may be used to illustrate this relationship.

Portland Cement Tests

We are all familiar with the various tests of Portland cement which have now been adopted as standard over practically the entire country. These tests must necessarily be conducted under rather strict conditions as to apparatus, temperature and other working conditions and make laboratory examination a necessity. The examination of Portland cement involves tests which may be grouped into three classes as far as the element of time is concerned. First, we have those tests which may be completed within a period of twenty-four hours; second, strength tests which may be completed at the end of seven days, and third, strength tests which may be completed at the end of twenty-eight days. Portland cement is usually required to pass all of these tests satisfactorily, but on account of the long time intervening between the beginning and completion of all of the tests, it has usually been the custom to provide for the acceptance of Portland cement on the basis of twenty-four-hour or seven-day tests, either tentatively or entirely reserving the right to require in one case seven and twenty-

eight day tests, and in the other twenty-eight day tests in case the cement fails on either seven-day or twenty-eight-day tests after having passed preliminary tests referred to.

Laboratory Tests

In the examination of sand, gravel, crushed stone and crushed slag, the services of a laboratory may properly be made use of most especially in the examination of preliminary samples. After the quality of these materials has been definitely determined and proper control may well be said to be a duty of the field inspector.

The examination of ledge rock, on account of the character of the tests involved, makes laboratory tests a necessity. The tests ordinarily conducted to determine physical qualities are: hardness, toughness, abrasion and compressive strength. These tests all require more or less expensive and heavy machinery which, for economy, must be located in a rather extensively equipped laboratory. After the quality of a certain product has been determined, further tests are not usually necessary within a period of one year's time of making the initial tests in those portions of the quarry at which operations are being carried out.

Proper inspection of paving brick involves the utilization of machinery which may only be properly installed in a laboratory, either at the plant itself, or in a central laboratory for the examination of such materials.

The quality of asphalt and tar products also involves the utilization of a properly equipped laboratory on account of the exacting methods of analysis required in this industry. The relationship between laboratory and field examination will be touched on later in this discussion.

In addition to these materials we have others, such as structural and reinforcing steel, corrugated metal pipe, paint, etc., which represent materials for which laboratory methods of examination are necessary.

As I have stated before, the proper examination of materials involves both laboratory and field methods. Most of us are familiar, at least to a certain extent, with the various methods utilized in the laboratory. Many recent developments, however, in the connection with desirable field control of materials are of particular interest and value at this time. It is my purpose to describe some of these various methods in an attempt to point out their value and the relationship which should exist between field and laboratory inspection with various materials.

Sampling Materials

Field work involves one of the most important of the operations in connection with all testing. I refer to the matter of sampling materials. It is perfectly evident to all of us that the proper interpretation of results of tests conducted, either in the field or in a laboratory, is necessarily dependent upon the method which has been used in obtaining the sample for examination. It may not be amiss to describe, in connection with various materials, some features of sampling which must be carefully observed in order to insure obtaining test results which are representative of the bulk of the material sampled and tested. In this connection we may refer to three features as the principal factors which must be observed in connection with sampling operations; first, the method of sampling must be such that the sample taken represents as accurately as possible the bulk of material sampled; second, the size of the sample must conform to the quantity of material necessary for conducting tests, plus an extra quantity to retain for reference purposes; and third, the container to be used in transmitting the sample of material from the point of sampling to the laboratory must be of satisfactory kind and size.

Cement Samples

Portland cement is used in very large quantities in both highway construction and maintenance. The necessity for careful sampling is quite evident on account of the method of manufacture and shipment of this material. It is now generally recognized that a sample of Portland cement should be taken from every 200 to 250 barrels of mat-

*Paper read before the Eighth Annual Conference on Highways Engineering at the University of Michigan on February 14, 1922.

erial, this quantity being approximately that contained in one car load. Portland cement is shipped in cloth or paper sacks, or in bulk. In taking samples for shipments in sacks, a small amount, let us say about $\frac{1}{2}$ lb., should be taken from each of about twenty sacks selected at random from a carload or an equal amount of cement. It is not necessary to open up the sack of cement to obtain the sample. A small valve is placed in the end of both cloth and paper sacks to be used for filling by means of the automatic sacking machines now generally used in all Portland cement plants. A small sampling tube may be inserted through these valve openings and the necessary quantity of cement obtained in this way without disturbing the sack itself. In the case of bulk shipments of cement, the most satisfactory method of sampling is by means of sampling rods with which we may be sure to reach all parts of the material. Cement samples may properly be shipped in closely woven canvas bags. The quantity actually required for testing is approximately five to six lb. and samples should preferably contain from 8 to 10 lb. of material.

Sand Samples

Sand samples should consist of about 20 lb. of material and should be obtained by taking small portions of material from various parts of the supply represented and combined to form a test sample. Samples of gravel and crushed stone should be taken in similar manner about 30 or 40 lb. of material constituting a proper size sample. These samples may be transmitted in canvas bags or tight boxes.

Stone Sample

General experience seems to teach us that a great deal of difficulty is usually obtained in securing representative samples of rock from ledges in quarries. As a first consideration rock should preferably be sampled by taking samples from all the different formations within the quarry. In some quarry examinations conducted for the Michigan State Highway Department the speaker has selected as high as 25 or 30 samples to determine the entire range of the material in a given quarry. Samples of ledge rock should consist of about forty pounds of material larger than $1\frac{1}{2}$ in. in size. At least one piece of material should be approximately 5x5x4 in. to enable cores to be drilled with a diamond drill for the hardness and toughness test. Owing to the nature of the material these samples should preferably be enclosed in tight boxes rather than shipping them in sacks which usually become destroyed or damaged in shipment.

Paving Brick

In the case of paving brick, samples should be taken which accurately represent one lot or shipment of the brick. One sample should be taken to represent the softer brick in each load or shipment, and another sample to represent the hardest brick. In addition, a third sample representing the general average of the material should be selected. Twelve paving bricks should constitute a sample and should be shipped in a box, or crate, preferably in rows with a partition between each six bricks.

Asphalt

Asphalt and tar products, if sampled from tank cars, should preferably be sampled at the time of loading in order to secure truly representative samples. When this is done, portions of the hot material may be taken at intervals during the loading of the car and combined to form the test sample. When sampling from drums or barrels, samples should be taken from a number of drums or barrels in each load or shipment, and combined to form the test sample. In the case of hard products care should be taken to reach the interior of the material and not to include the surface skin, together with any foreign material which may have become adhered thereto. Care should also be taken not to take samples in these cases from material exposed to the weather, and on which free water is standing. The sampling of corrugated metal pipe should preferably be performed at a fabricating plant, but owing to the intermittent shipment of these products, such a procedure is useless un-

less central purchasing in large quantities is generally practiced. When samples are taken after pipe has arrived on the ground, it is necessary to use a heavy pair of metal shears, or a hack saw to remove the sample. On account of the work involved, and the danger of damage to the sample, field methods of testing are particularly desirable in the case of this material. A field method of testing these products has already been devised and it is the writer's opinion that its use will be more generally adopted in the future. The necessity for the use of glassware and chemicals is an objection to carrying such a testing outfit in the field.

Testing in the Field

In the field testing of materials, these various features in regard to sampling are just as necessary and should be followed out as carefully as when taking samples which are to be sent to a central laboratory.

The testing of materials in the field is naturally confined to those tests for which equipment may readily be manufactured which is comparatively inexpensive and easy to transport, and to those tests which do not require strict conditions of temperature or methods of analysis which can only be carried on in an enclosed room under exacting conditions. As stated before, the testing of such material as Portland cement is a laboratory process. Sand, gravel, and crushed stone may, however, be examined in the field with a good deal of efficiency.

Field Testing Sand

The testing of sand in the field is of considerably more importance than is generally recognized, both in connection with preliminary tests and with the control of materials from known sources of supply. The tests which are ordinarily conducted on sand are tests to determine cleanness, both as to organic matter and clay content, size and grading, and strength in mortar. The latter test is essentially a laboratory test. The size and grading of sand may readily be determined by a set of field screens and sieves. The determination of quantity of clay and silt in sand may readily be made in the field on a volume basis by selecting a sample of the material, mixing it thoroughly, and cutting it down to a size suitable for testing. This small sample is then placed in a graduated glass cylinder together with water, and the whole vigorously agitated without whirling. The percent of clay and silt, by volume, may then be determined by measurement of this material which is in the upper part of the cylinder and which may be readily noted by the eye.

It is the writer's opinion that the determination of organic matter in sand is one of the most important tests that may be applied to this material. The relationship between organic content and decrease in strength of both mortar and concrete has been quite definitely determined, and the low strength of concrete, in many instances, may be traced directly to this particular feature of the sand. Small variations in the properties of Portland cement and other features of aggregates are of insignificant importance if organic matter is present in the sand in any considerable quantity. Fortunately this quality of sand may be determined in the field by a comparatively simple method. The test as it is usually made consists of thoroughly digesting the sand with a 3% solution of sodium hydroxide and observing the resultant color of the liquid above the sand after the mixture has been allowed to stand for a few hours. This procedure may be briefly described as follows: A 3% solution of sodium hydroxide may be made up by dissolving one ounce of sodium hydroxide (obtainable at any drug store), in enough water to make 32 liquid ounces. Fill a twelve ounce graduated prescription bottle to the $4\frac{1}{2}$ ounce mark with sand to be tested, add the 3% solution of sodium hydroxide until the volume of the sand and the solution, after shaking, amounts to seven ounces. The mixture should be shaken very thoroughly and allowed to stand for 24 hours. If the solution resulting from this treatment is colorless, or has a light yellowish color, the sand may be considered as practically free from organic impurities and satisfactory for use insofar as this quality is concerned. If, on the other hand, a dark brown colored

solution is obtained, the sand should not be used for concrete aggregate. The time indicated above, of 24 hours, is usually the standard time allowed for settlement of the solution. A very good idea of the character of the sand, however, may be obtained in a much shorter period.

The size and grading of gravel and crushed rock may be obtained very easily by means of a compact set of field screens and sieves.

Testing Water for Concrete

Occasionally one desires to use a source of water for concrete which appears questionable. While it is true that in the State of Michigan we seldom encounter unsatisfactory supplies of water, nevertheless, simple tests can be made in doubtful cases to determine whether any supply is objectionable. Strips of red and blue litmus paper can be used by inserting them in the water for a period of five minutes and noting the color produced. A marked reversal in color indicates the presence of acids or alkalis, and makes further laboratory tests advisable. Laboratory tests usually consist of determination of total solids and quantity of organic matter present, or a comparison of the given water with a water of known satisfactory quality by making standard tests of a sample of cement which is known to be satisfactory.

Control of Cement Concrete

An important part of the work of field control of materials is in connection with the control of cement concrete entering into either concrete pavements or other concrete structures such as bridges, culverts, retaining walls and other similar structures. Due to the large amount of investigative work which has been completed in the last two years, we know a great deal more about the importance of certain features in connection with the manufacture of cement concrete than was the case a few years ago. Time of mixing, method of curing, and the consistency of concrete are now recognized as among the most essential elements affecting the finished product. Time of mixing and method of curing may be easily controlled by the field forces on a construction project.

Consistency or the percent of water in concrete is another item which has often been neglected in the past, but which is now receiving more careful attention on the part of both construction organizations, such as contractors, state and municipal forces. We know, beyond a doubt, that a dry concrete is much stronger than a wet concrete, all other conditions being equal. Two methods have been devised for determining the consistency of concrete, only one of which is readily adaptable for use in the field. This method is known as the "slump" test and is conducted by placing concrete, fresh from the mixer, in a metal mould 12 in. high, 8 in. in diameter at the bottom and 4 in. in diameter at the top. This form is placed on a level and preferably a non-absorbent surface, such as a metal plate. The concrete is placed in the open end in approximately three layers, each layer being rodded with a $\frac{1}{2}$ -in. or $\frac{3}{4}$ -in. steel rod, preferably pointed at the end. After the form is filled, the rod may be used to strike off the concrete level with the top of the form. The form is then carefully removed by raising it in a vertical direction, and the distance which the concrete slumps down, or in other words, the difference between 12 in. and the remaining height of the concrete after the form is removed, generally denoted as the "slump," is considered as a measure of the consistency of the material. The entire apparatus for this simple field test can be obtained at a cost of two or three dollars, and if kept properly cleaned, may be used for several seasons.

Tests of the concrete itself may be conducted in a laboratory by taking specimens for tests of compressive strength, wear or cross breaking strength. Probably the most logical test to use is the one involving the cross breaking strength of the material. This test, however, unless laboratory facilities are provided very close to the work, is impracticable on account of the necessarily large size of the specimen and the cost of transporting it to

the laboratory. Compressive strength tests or tests for wear have generally been utilized to a greater extent.

Plant Testing

We have referred to the general plan of laboratory testing. Laboratory testing may be conducted in a central laboratory or in a temporary laboratory connected with or near the manufacturing plants at which the materials are actually produced. Plant testing depends to a great extent upon economy in connection with such procedure. When an organization is obtaining a large volume of the products of any given plant it may often be economical to test the product of the plant itself. This method is by far the most convenient one on account of the fact that the quality of materials can usually be determined, and results of tests made known on the job prior to shipment or receipt of the material. In this connection the testing of Portland cement offers one place where plant testing may often be followed economically. The use of aggregates of either sand, gravel or crushed stone on a large scale always makes it desirable to follow up inspection of these materials at their source. As in the case of Portland cement these materials can readily be tested at the plant, and their quality determined prior to shipment. In connection with aggregates it is extremely important that the plant inspector actually inspect the loading of each car of material.

Bituminous materials such as asphalt cement and various tar products may also be properly tested at plants.

Where plant testing is not followed it is desirable, in the case of such materials as Portland cement, asphalt and tar, to station samplers at these plants and have samples taken at the time of shipment, which may be transmitted to a central laboratory and test results obtained as soon as possible after receipt of the samples. Plant samplers in these cases usually consist of men who do this work in addition to some other duties.

In the case of large organizations embracing a rather large area of territory, the establishment of branch laboratories in connection with the main laboratory for testing materials may be followed out economically, and will serve to measurably increase the facilities for the inspection of materials. As an illustration, we may take the work of the Michigan State Highway Department, which is scattered over a large area. On account of the fact that the Upper Peninsula is situated so far from the seat of government, and the location of the State laboratory, a branch laboratory located at some city in the Upper Peninsula should work out as a very convenient and necessary arrangement. In addition a branch laboratory for the upper portion of the Lower Peninsula would likewise appear to be desirable. It is quite possible that some such arrangement as this may be worked out in the very near future.

Re-Testing Materials

In connection with the examination of materials it may be well to consider one phase of the subject which possibly, in the minds of some of you, is misunderstood at the present time. I refer to the matter of re-testing of materials, which on original test have failed in some one or more particulars, and particularly to the case of Portland cement.

We have already discussed the various properties of Portland cement, dividing them into three classes according to the time necessary to complete tests. These properties may also be divided into two other classes; into one of which we would place those properties which are unchangeable, or very nearly so, in their nature; into the other class we may place those properties of cement which may undergo changes. Under the first classification we have such properties as fineness, and to a limited extent, tensile strength of standard mortar. In the second classification we may place the properties of time of setting and soundness.

When a cement upon original test fails on fineness it does so because of the fact that the material is not ground finely enough to meet the requirements of the standard specifications for size of particles. This property is

changeable only to a very slight extent and hence rejections on this property do not warrant re-testing of cement unless sampling has been performed in an entirely unsatisfactory and improper manner.

If a cement fails on time of settling or soundness, the user, if he desires to hold the material for a re-test, may properly request that another sample be taken and tested from a certain load or shipment which has previously failed on either or both of these tests. The user, whether a contractor or an organization, whichever the case may be, must necessarily resume all the responsibility for the cost of holding the material for this re-test.

In the case of failure of cement due to low tensile strength, a considerable amount of time is necessary in order to complete a second test. Therefore, the matter of economy enters very materially into the question of re-testing.

Laboratory Administration

It perhaps may not be out of place to refer to some features in connection with the administration of laboratory work.

On account of the fact that laboratory tests of materials involve shipments of considerable value, it is absolutely essential that the work of testing be carried on by efficient workmen, thoroughly trained, and performing their work according to certain definitely outlined methods. Methods of examination of materials used in highway improvement have been largely the result of work done by organizations such as the U. S. Bureau of Standards, U. S. Bureau of Public Roads, The American Society for Testing Materials, The American Society of Civil Engineers, and other like organizations. At the present time the testing of these various materials has been placed on a more or less of a standard basis, and the work of testing carried on throughout the country is rapidly becoming more and more standardized, using more uniform methods.

It may readily be seen that extreme accuracy is necessary in the conduct of this work, and that an error due to lack of training or carelessness is very much more serious than often is the case in connection with construction work itself. For this reason the training of men engaged in this work becomes of paramount importance.

In the laboratory of the Michigan State Highway Department, both technical and non-technical men are utilized in the examination of materials, each working in the sphere for which he is particularly fitted. Operators on Portland cement who conduct physical tests only are not permitted in the case of such tests as time of setting, soundness, and tensile strength, to perform routine tests until they have passed through a period of training of from two to three months, working under the direction of experienced men. In many cases this period has actually, on account of existing conditions, been extended to far greater periods. The same is likewise true with reference to other materials and every effort is made, in the cases of failure, to meet certain specification requirements, to carefully ascertain by means of check tests that the results obtained are correct.

The work of the testing laboratory is not confined entirely to the routine testing of materials. Many other duties are part of a laboratory's responsibility. In addition to the routine testing of materials it should be the duty of a laboratory to assist in the proper usage of materials, to aid in the advancement of knowledge of materials, by conducting investigations and work of a research nature, and by assisting in ascertaining and recording the extent and properties of local materials available for use; also by assisting in the preparation of specifications for materials. It should also be the duty of a laboratory to keep a record of materials tested in such a way that at any time the nature of materials entering into any given portion may be quickly and accurately determined. Last, but not least, the utilization of a laboratory in the training of employees in the use of materials is most certainly a valuable and essential part of its work. This function of the laboratory cannot be measured in the number of tests conducted, or quantity of material represented by tests, but is

nevertheless a very important service to public organizations.

The co-operation of a central testing laboratory with field forces, involves not only accurate and speedy service on the part of the laboratory, but a willingness to assist field forces in every way possible. The administration of laboratory work along these lines is essential to the efficiency of the organization with which it is connected to insure the obtaining of materials of proper quality, the proper usage of materials on work, and the recording of data of value to the organization it serves.

GOOD ROADS CONVENTION AT VICTORIA

ENTHUSIASM marked the opening session of the ninth annual convention of the Canadian Good Roads Association at Victoria, B.C., last week. The convention brought together engineers and officials from every province in the Dominion and many prominent highway engineers from the United States. Hon. S. J. Latta, in his presidential address, declared that human necessity and traffic requirements should be the guiding principle in the selection and location of a system of highways, rather than adherence to an artificial system of straight lines. To this end, the following details should be considered: The greatest good to the greatest number, most direct route possible for traffic, avoidance of sharp curves, advantages of easy grades, minimum construction cost, economy of maintenance, correlation of each road selected and located to all other portions of the whole system, relation of the road as a feeder to the railways, drainage facilities, proximity of road material, future requirements, necessity for bridges and culverts, money available for the project proposed.

Hon. J. L. Perron, Minister of Highways, Quebec, expressed the pleasure of Quebec officials at being present at the convention. They were greatly impressed with the wonderful possibilities of British Columbia.

S. L. Squire, past president, and member of the advisory committee, spoke of the great purpose of the association in order to carry out the principles and objects for which delegates were prepared to travel many miles to discuss with their brother Canadians. Six hundred million invested in highways in Canada must be protected. Fifty millions have been wasted by municipalities in road experimenting. There is need for strict economy, but we also need more and better roads, and in the building of these must be as liberal as possible.

At the opening session on Tuesday, A. W. Campbell, Chief Commissioner of Highways, Ottawa, addressed the convention. He said that it would be only a few years before every section of the Dominion would have all the permanent roads required. There are 18,000 miles of main roads in the various provinces and in due course these would be linked up, so that there would be a main highway across Canada. No one section of Canada, he said, was progressing more than another, but all were making headway in road construction.

Addresses were also given by G. P. Graham, engineer, of Albany, N.Y.; A. W. Campbell, chief commissioner of highways, Dominion Government, Ottawa; and J. C. Robertson, deputy minister of public works, Alberta.

In the afternoon the officers for the ensuing year were elected. Hon. J. L. Perron was elected president. The other officers are: Honorary president, Hon. S. J. Latta, Regina; first vice-president, Russell T. Kelly, Hamilton, Ont.; second vice-president, E. L. Follows, Vancouver; secretary-treasurer, G. A. McNamee, Montreal.

The following directors were elected: Mayor Beaubien, Outremont, Que.; H. S. Carpenter, Regina; William Finlay, Toronto; George Hogarth, Toronto; J. D. Robertson, Edmonton; P. Hillis, Victoria; S. H. Henderson, Winnipeg; G. Fred Pearson, Halifax; R. D. Patterson, St. John; A. M. Hankin, Collins Bay, Ont.; T. J. Mahoney, Hamilton; H. H. Shaw, Charlottetown; J. A. Duchastel, Montreal; P. Gomny, Vancouver; R. P. Murray, Halifax.

PRESENT TREND OF HIGHWAY DEVELOPMENT

Joints for Brick Pavements—Flexible and Semi-Flexible Types of Pavement Predominate in Highway Construction—More Attention Being Paid to Drainage

By Prevost Hubbard,
Chemical Engineer, The Asphalt Association

DURING the construction of our state and county highway systems, it is an almost incomprehensible fact that more weight has not been attached to paving practice in our cities where many of the problems of meeting heavy and varied traffic conditions were successfully solved before such conditions made their appearance on country and suburban highways. In our cities the original waterbound macadam and gravel roads have for the most part given way to higher types of construction until today they constitute an average of only about 26 percent of the total yardage. The three most most widely used city types are asphalt, brick and stone block. If we eliminate the waterbound pavements we find that of the higher city types, asphalt constitutes about 55 per cent, brick about 19 per cent and stone block about 14 percent, giving a total of 88 percent for these three types.

Flexible Joint Filler

In connection with the preponderance of asphalt pavements, the present trend of paving practice in the construction of modern brick and stone block pavements is of considerable significance, as it recognizes a principle which just now is attracting a great deal of attention on the part of our highway engineers. I refer to the use of a flexible joint filler for brick and block pavements as against the rigid grout fillers, formerly so popular. Such cities as New York and Philadelphia are now using asphalt fillers for heavy traffic streets with stone block and the Paving Brick Manufacturers Association are preferentially recommending asphalt as a filler for their type of pavement. The reason for this lies in the fact that absolute rigidity in a pavement structure is not a desirable characteristic. Service results and comprehensive field tests conducted by the U. S. Bureau of Public Roads, have demonstrated that the brick or block pavement with a flexible filler is more resistant to traffic than with a rigid filler. A certain degree of flexibility is highly advantageous in meeting the heavy impact of modern traffic. Such flexibility is an inherent characteristic of bituminous pavements and is imparted to brick and block pavements when asphalt is used as a joint filler.

Flexible Types of Construction

While in certain sections of the country the experience of our cities appears to have been overlooked, it is a fact that the flexible or semi-flexible types of construction predominate in our country roads and if we consider the total mileage of state, county and municipal highways higher than gravel and macadam, considerably more than 50 per cent may be so classed. By reducing all yardage to a basis of 16 ft. width, we estimate that at least 45 percent of the mileage of the higher types of pavements are of the hot-mixed asphalt types. The latest available information indicates that last year the total area of asphalt pavements constructed approximated 68,000,000 sq. yds., which was greater than for any other type. Most of the stone block pavements constructed that year were filled with bituminous material and about 60 percent of the brick pavements were similarly filled.

There are, it is true, many advocates of the all rigid monolithic types of construction and in certain sections such pavements predominated in last year's work. This is not true, however, of the country as a whole. Those who favor rigid construction have constantly been obliged to increase the massiveness of design of such pavements and also the amount of reinforcement in an endeavor to successfully meet the destructive action of heavy traffic, while those who have favored the semi-flexible or flexible types have, in general, found that the old standards of design

have proven satisfactory. The all flexible types, such as the black base pavements so extensively adopted in our far western states appear to be the most highly resistant per inch of total thickness, and may therefore be considered the least massive and in this respect the most efficient of the heavy traffic pavements.

It is probable that such pavements will be given considerable attention in the 1922 program of some of our eastern states owing to the remarkably satisfactory results obtained over a long period of years in the west. Many of these pavements are 6 in. or less in total thickness.

Instances of Satisfactory Service

What we have learned in the last few years about the destructive effect of traffic impact and the resistance of impact offered by semi-flexible and flexible highway structures, has a peculiar significance in connection with a great economic problem, that of conserving our investment in old roads, particularly gravel and macadam, when it becomes necessary to adopt a higher type of wearing surface. Prior to the careful investigation of this important subject there existed a marked and growing tendency to discredit the use of old gravel and macadam roads for foundation for the higher types and this in spite of many remarkable service records of macadam foundations. For example, in the City of New York, a number of the most heavily traveled streets were constructed years ago on macadam foundations and some are still giving satisfactory service. In 1890 Broadway, between 59th and 79th streets, was paved with asphalt over an old macadam base and for 22 years gave good service. Its replacement at the end of this period was largely due to subway excavations. Seventy-second street, paved in a similar manner, also gave 22 years of service under increasingly severe traffic conditions and the same is true for a 19-year period for Fifth Avenue between 110th and 120th streets. Lenox Avenue between 110th and 124th streets was surfaced with asphalt over old macadam in 1914 and is still giving good service. The cost of maintaining this section in 1919, 14 years after construction, was only one per cent, certainly a remarkable record. Many similar cases might be cited from various localities.

A recent investigation of rolled stone bases for brick pavements was conducted by the U. S. Bureau of Public Roads and A. T. Goldbeck of that Bureau has published a very favorable report on this type of brick construction. All in all it appears that the old waterbound base is again coming into its own.

Inadequate Drainage

One reason for much of the former dissatisfaction for such bases was undoubtedly due to a fault which has been all too prevalent in the rapid development of our country highway system. I refer to inadequate preparation and drainage of our subgrades, fostered by the false idea that the cost for such work would make the total cost prohibitive. Political pressure and popular demand for the rapid construction and the greatest possible mileage of improved roads for a given amount of money has been, to a great extent, responsible for this state of affairs. However, this subject is receiving an increasing amount of attention and is being most carefully investigated by the Government and a number of public service bodies and technical societies, the work of the various organizations being correlated by the Advisory Board on Highway Research of the National Research Council. Most of our highway engineers are now fully alive to the importance of this subject and marked improvement in our present practice of subgrade preparation and drainage will shortly follow.

There is one other common fault in the utilization of old roads for foundations which has often resulted disastrously. This is the over estimation of thickness of the old road. All too frequently we have laid an expensive pavement on an old road, actually 3 in. or less in thickness when it had been estimated as not less than 6 or 8 in. thick. Macadam and gravel roads wear away very rapidly in comparison with other types because records show that

a large tonnage of road metal has been used in the construction and maintenance of the old road, it does not by any means follow that most of such material is still on the road. It is very essential, therefore, to determine accurately the existing thickness of the old road before utilizing it as a foundation.

Wherever possible the old road should be left undisturbed rather than to scarify and reshape it, which destroys much of the stability that compression under traffic has brought about. It is quite necessary that the old surfaces be trued up before the wearing course is laid, but if the reconstruction is to be completed in one operation, the placing of a bituminous mixture in existing depressions will usually prove to be the best practice. If the existing road is not sufficiently thick to serve as a foundation, it may conveniently be reinforced with a thin course of black base mixture before the wearing course is laid.

Engineer's Library

HYDRAULICS OF PIPE LINES

Reviewed by Thos. H. Hogg,

Assistant Hydraulic Engineer, Hydro-Electric Power Commission of Ontario.

HYDRAULICS OF PIPE LINES—By Dr. W. F. Durand, Professor of Mechanical Engineering, Stanford University, California. (The Glasgow Text Books in Civil Engineering, edited by G. Moncur, Professor of Civil Engineering in the Royal Technical College, Glasgow.) New York: D. Van Nostrand Co. Cloth; 6 by 9 in.; pp., 271; 134 line cuts. \$4.50.

This treatise is evidently not intended as a complete discussion of the subject of pipe line design, but nevertheless treats the question rather fully from the descriptive as well as the mathematical or analytical standpoint.

The first chapter deals with the hydraulics of flow in pipes, presenting in brief form certain of the formulae for determining the loss of head. Head losses due to bends are fully treated, while valves and sudden enlargements follow the stereotyped method of treatment of the standard hydraulic textbooks.

Chapter II presents the surge problem and this is probably the predominant feature of the book. Only the analysis of the simple tank is given, and attention is drawn to the fact that the simple tank is not necessarily cylindrical in shape.

It is unfortunate that the question of the differential surge tank is so inadequately treated, being dismissed with a reference to the available literature on the subject. No engineer is justified in ever using the simple tank, for the differential tank has all the advantages and none of the faults of the former. It is safe to predict that in a comparatively few years, when engineers are educated to its use, that the differential tank will entirely supersede the simple tank, which, by the way, is simple only in name.

Water hammer in pipe lines is treated at length in Chapter III, and here again one is inclined to be critical. The work of N. R. Gibson in the analysis of pressure rise in pipes due to slow closing of valves or gates is probably the only adequate treatment in English, yet this work is not referred to, although it may be noted that Mr. Gibson's method of treatment is used by the author.

The chapter on the stresses in pipe lines is very adequately treated; there is also a chapter on materials, construction and design; and also one on oil pipe lines that should prove of interest to many engineers.

It is with a feeling of regret that one closes the book. The treatise might have been made most complete and authoritative if proper space had been allowed for the recent work of other engineers in connection with the analysis of

the surge tank, and of pressure rise. These two phases of pipe line flow are undoubtedly the most important, and the book as it stands treats these subjects in a very inadequate manner in the light of present-day practice.

DEEP HOLE AND SUBMARINE DRILLS. Form K-216, Canadian Ingersoll-Rand Co. This pamphlet is devoted to an illustrated description of the class "H-66" deep hole drill as used on the Chippawa Power Canal and other important engineering works. Details of construction are included.

THE LUBRICATION OF AIR COMPRESSORS. Form K-325. This is a 12-page pamphlet containing a copy of the practice recommended by the Compressed Air Society, the paper itself being written by H. V. Conrad, M.E., former secretary of the society in question. This pamphlet, which is issued by the Canadian Ingersoll-Rand Co., will be of undoubted interest to those who have to do with the operation of air compressors for all kinds of service.

CANAL STATISTICS, 1921. This report which covers the year ending December 31, 1921, containing 54 pages, comes from the office of the Dominion Bureau of Statistics, Transportation Branch, and contains some very interesting information regarding the freight prassing through the various canals throughout Canada. It also gives a good deal of information regarding the location and description of the various canals, grain shipments, historical tables, etc., all of which makes the publication of very great interest to those who are concerned with water transportation matters.

THE PYRAMID. We have received a copy of this new publication which has been issued by the Vitrified Clay Publicity Bureau. The leading article explains the basis upon which the "Pyramid" is built and outlines the object of its publication, namely, to give out from time to time, facts concerning the history of clay products; changes that have taken place; their present-day manufacture and their modern application. The publication is printed on coated paper, tastefully illustrated and contains fourteen 5 x 7 1/2 in. pages. All those who are in any way interested in the use of vitrified clay products will find many helpful suggestions in this new publication.

EMPIRE MUNICIPAL DIRECTORY AND YEAR BOOK, 1922-1923. The 40th edition of this well-known year book contains a complete list of all the corporations, county, urban and rural districts, not only in Great Britain and Ireland but in the overseas Dominions, and is recognized as a most useful work for reference purposes. A most complete directory of municipal and sanitary engineering equipment is included, and altogether the 1922-23 edition excels all preceding issues insofar as the reference value of the publication is concerned. It contains nearly 300 pages and is published by the "Sanitary Record" London, England, and sells for 10/6, net.

ASPHALT PAVEMENT CONSTRUCTION. The Texas Company, New York City, issue from time to time a number of very useful, well illustrated booklets on different types of asphalt pavement construction.

This series includes booklets on sheet asphalt, asphaltic concrete, asphalt macadam, asphalt filler, asphalt to resurface worn brick, and asphaltic road oil. In addition this company has for distribution a portfolio, entitled, "What Is Your Highway Problem," which gives a brief resume of the facts of each highway construction use to which asphalt is put.

All who are interested in the design, construction and maintenance of pavements will find much to interest them in these booklets and anyone desiring any of them, may very readily secure copies by addressing a brief request to the Asphalt Sales Department, The Texas Co., 17 Battery Place, New York City.

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RAILWAYS AND HIGHWAY TRANSPORT.

SPEAKING at the annual meeting of the National Highway Traffic Association recently held in New York, Professor Arthur H. Blanchard, of the University of Michigan, pointed out the vital relation of highway transport to the railways. There are some railway operators who unfortunately have viewed the highway with hostility, but the attitude of friendliness is becoming increasingly common. Progressive railway managers realize the vital importance of highways as feeders to the railways, and, in many cases, have adopted highway transport to a greater or lesser extent as an auxiliary.

Numerous methods of employing highway transport for the more effective carrying out of the function of the railway have been adopted. There is, for example, the inter-terminal transportation of freight by motor trucks carried out in a successful manner in such cities as Cincinnati. There is the intra-terminal and freight yard highway transport involving the transferring of commodities to shipping platform and warehouse. There is the collection and delivery of freight in municipalities adjoining areas. Notable examples of this are to be found in Great Britain, where, in the case of the London and North Western Railway, 350 motor vehicles were operated in 1920. Again, there is the possibility of extending the transportation service of the railway through the medium of motor truck and motor bus routes. Instances of extension of the service of electric railways in this manner are already common in Canada, but a much higher development of the system in connection with steam railways has been attained in Great Britain.

It is interesting to note that the same modification or attitude of the steam railway to highway transport is occurring as has been seen in case of the electric railway and highway traffic. The electric railways now frankly admit the value of motor bus and motor truck service as an auxiliary and the steam railways are undoubtedly coming to the same point of view.

TECHNICAL GRADUATES IN RAILWAY WORK

AS a result of an analysis of the personnel of the Pennsylvania Railroad, Samuel Rea, president of the system, recently stated that of the 163 principal officers and directors of the system, there are 86 college graduates. However, since for every 100 men entering the service with a college education, there are thousands who start without one, Mr. Rea concludes that the college graduate has a much greater chance of reaching a position of great responsibility in railroad work than has the young man without such advantage.

Of special interest to the engineer is the fact that the company's statistics show that the most advantageous courses are those in civil engineering and mechanical engineering. Out of the 163 leading officials already mentioned, 81 are in the operating department and of these 81, no fewer than 54 are college trained men. Of these 54 college men, 38 are civil engineers, 11 are mechanical engineers, one is an electrical engineer and 4 are graduates of academic departments. If the analysis were made of the younger operating officers, who in a very short time will be in charge, consequent on the retirement of many officials now reaching the retiring age, it would be found that nearly all are college graduates.

Such a conclusion as has been reached by Mr. Rea goes a long way toward counteracting the somewhat discouraging views respecting university education expressed by Thomas A. Edison and others of his school. In spite of the fact that college graduates may be right only 60% of the time, as stated by Mr. Edison, the great corporations and important governmental departments are persuaded that a university education is well worth while.

VALUABLE WORK OF THE ONTARIO BOARD OF HEALTH

OUTLINING the activities of the Ontario Board of Health since its establishment, F. A. Dallyn, sanitary engineer for the board, pointed out at the recent meeting of the Canadian section of the American Water Works Association, many particulars in which the board is contributing to the welfare and health of the people of Ontario. For example, it was stated that whereas in 1910 the death rate per 100,000 population from typhoid was 22 in the counties, it was in 1920 6.2; in the cities it dropped from 51.5 to 5.5 in the same period; in the towns from 56.4 to 25; and for the entire province from 31.5 to 7. No more striking proof of the valuable services of the provincial health authorities could be given.

Outlining the policy of the board, Mr. Dallyn pointed out that its function was purely supervisory. It did not undertake to solve the problems of municipalities, and aimed to give considerable latitude so long as the sanitary welfare of the community was properly conserved. Such a policy, we believe, is a sound one. As was pointed out, the funds at the disposal of the board do not permit it to delve deeply into municipal situations, and, it is doubtful if the co-operation of the municipalities could be maintained if such were done. So long as the function of the board as outlined is observed, this very useful body should continue to perform an increasingly valuable service to the province.

A. E. HANNA, 410 Montreal Trust Building, Winnipeg, Man., has been appointed by F. H. Hopkins & Co., Ltd., of Montreal and Toronto, as their representative for the Prairie Provinces.

PERSONALS

N. H. POWELL has been re-appointed road superintendent of Peel County with office at Brampton, Ont.

GORDON KIRKS, of the engineering staff of the Ontario Hydro-Electric Commission, has been appointed chief electrical engineer for the New Brunswick Electrical Power Commission.

DR. FRANK D. ADAMS, vice-principal of McGill University, dean of the Faculty of Applied Science, has been appointed chairman of the Dominion Advisory Council for Scientific and Industrial Research, by the Governor General-in-Council.

J. R. MONTAGUE, Who resigned from the hydraulic engineering department of the Ontario Hydro-Electric Power Commission in 1920 in order to become chief engineer for D. G. Loomis & Sons, contractors, Montreal, has returned to the Hydro staff and is now engaged on construction work in connection with the Queenston development.

H. P. FIERHELLER, who has been a member of the purchasing staff of the Ontario Hydro-Electric Power Commission for several years, has been appointed as publicity manager for the Commission, succeeding W. M. BOSTWICK, who resigned in order to accept a position as publicity manager for the West Penn Power Co., Pittsburg, Pa.

J. B. NELSON, who has been in private practice as an inspecting engineer in Toronto for the past few months, has accepted a position on the engineering staff of the Dominion Bridge Co., Ltd., Lachine, Que. Mr. Nelson was formerly a structural engineer in the building department of the Ontario Hydro-Electric Power Commission.

HENRY PERCY BORDEN, who recently entered private practice in Ottawa, Ont., as a consulting civil engineer, was born on December 8, 1872, in Port la Tour, N.S. He was educated at Mount Allison University, Sackville, N.B., and at McGill University, Montreal, where he graduated in 1902 with the degree of Bachelor of Science. Mr. Borden began his technical career as an assistant engineer in the bridge department, Canadian Pacific Railway Co., Montreal, where he served from 1902 to 1904. In the latter year he was appointed as assistant chief engineer of the structural department, Montreal Locomotive Works, but two years later he returned to the C.P.R. as an architectural engineer. In 1908 he received an appointment to the staff of the Quebec Bridge Commission as an assistant engineer and secretary, and in 1915 he was promoted to be assistant to the chief engineer of the Commission.



In 1916, upon the death of C. C. Schnelder, the Dominion Government appointed Mr. Borden as a member of the Board of Engineers, Quebec Bridge, which position he held until the completion of that work in 1918. From 1919 to 1921 he was engaged by the Dominion Government in a consulting capacity, and a few years ago Mr. Borden opened his office in Ottawa, with the intention of specializing in bridges and structures in steel and reinforced concrete. Mr. Borden is a member of the Engineering Institute of Canada and of the American Society of Civil Engineers.

L. S. TRAINOR has been appointed district engineer in charge of the Illinois district of the Portland Cement As-

sociation, to succeed C. M. POWELL, resigned. This office, located in the Conway Building, Chicago, has charge of association work in Illinois. Mr. Trainor has been connected with the Portland Cement Association for the past three years, and has been engaged principally in Southern Illinois. Prior to joining the Association staff, he was county superintendent of highways, Marion County, and city engineer of Centralia, Illinois.

OBITUARIES

WILLIAM G. CHARLESON, a leading contractor of Ottawa, died at the Wellesley Hospital, Toronto, recently. The deceased was born in Quebec in 1867 and moved to Ottawa 35 years ago.

WILLIAM FRASER, well-known architect of Toronto, died at his home in that city on June 14. The late Mr. Fraser was born in Lochgilhead, Scotland, in 1868 and came to Canada in 1907. He was associated with the firm of G. M. Miller.

JOSEPH H. GREER, contractor, died at his home in Ottawa on June 11, aged 69. The deceased was born in Ireland and came to Canada 50 years ago, settling at Morewood, Ont. Later he moved to Winchester, Ont., residing there until about four years ago, when he went to live in Ottawa.

FEDERAL ROAD GRANT TO ONTARIO

UP to date the Ontario Department of Highways has received slightly over one and a half million dollars of Federal road subsidy, on account of expenditures already made on Ontario road construction. A cheque for \$47,000 received yesterday is the latest payment out of the allotted Federal funds.

Most of the amount received up to date covers work performed back in 1919 and 1920, although there is a small amount on hand on account of 1921 expenditures. There is understood to be almost two and a half million dollars coming to the Province on account of work done last year.

The Province is undertaking much more than sufficient work to earn its portion of the Federal appropriation, approximately \$5,000,000, and already more than two-thirds of the amount has been earned.

HALIFAX NOW HAS HYDRO POWER

HYDRO-ELECTRIC power from the St. Margarets Bay development is being used in Halifax, the transfer of the load from the steam plant having been made recently. The St. Margaret's Bay plant was constructed by the Nova Scotia Power Commission, a creation of the Provincial Government, which financed the undertaking. This commission has made a contract with the Nova Scotia Tramway and Power Co. to distribute electric current in the city at rates to consumers subject to the Board of Public Utilities. The St. Margaret's Bay plant has a capacity of 6,000 h.p., and the transmission line to Halifax is 18 miles long.

LONDON GEODETIC SURVEY

WORK has commenced on the 1922 section of the London geodetic survey. Considerable progress was made last year in the accurate mapping of the city and it is believed that by the close of the present season, the first geodetic map of the city will be very close to completion. This map will be the key to future town planning work in London and vicinity. Any plan of future city beautification adopted now would be liable to change, in view of the fact that present city maps are more or less incorrect.

The convention of the Association of Municipal Electrical Utilities will be held at Niagara Falls, Ont., on June 22, 23 and 24.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Nassau, New Providence, Bahamas, dredging	July 15	May 9
Quebec, Province of, construction of road from Quebec to Ste. Anne de Beaupre	Jun. 23	Jun. 6
Quebec, Province of, construction of oiled waterbound macadam on a num- ber of roads	Jun. 27	Jun. 6
Saskatchewan, Province of, construction of earth road from Canora west six miles	Jun. 21	Jun. 6
Oakville, Ont., laying of cast iron suction pipe, constructing extension to pump house and furnishing and erecting gasoline or oil engines, turbine pumps and electric generator	Jun. 22	Jun. 6
East Nissouri Tp., Ont., construction of bridge	Jun. 29	Jun. 13
Montreal Division, C.N.R., construction of six structures	Jun. 24	Jun. 13
Nipissing and Nipigon Divisions, C.N.R., construction of nine structures	Jun. 24	Jun. 13
Ottawa Division, C.N.R., construction of two structures	Jun. 24	Jun. 13
Quebec, Province of, construction of oiled waterbound macadam on several roads in town of Ste. Therese	Jun. 27	Jun. 13
Calgary, Alta., supply of one motor-driven combination pumping engine and hose car	Jun. 30	Jun. 13
Etobicoke Tp., Ont., waterworks equip- ment	Jun. 26	Jun. 13
Lakeside, Ont., completion of drain	Jun. 29	Jun. 13
Port Burwell, Ont., repairs to breakwater	Jun. 28	Jun. 13
Ontario, Province of, work on Provincial Highways	July 7	Jun. 13
Kincardine, Ont., slow sand filters and equipment	Jun. 27	Jun. 13
Elmira, Ont., construction of sewers	Jun. 24	Jun. 13

BRIDGES, ROADS AND STREETS

Annan, Ont.—Council awarded contract to McKenzie & Symon, of Warton, for construction of an arch bridge for \$1,030, and culvert for \$240. Tenders were also received from Bryson & Irwin, Warton; Farrow & Corlett, Chatsworth; W. G. Moore, Allenford; and Wm. Clark & Son, Owen Sound.

Barton Tp., Ont.—Tenders will be received by Alfred G. E. Bryant, Clerk, Room 1, Court House, Hamilton, until noon, June 17, for construction of concrete sidewalks and macadamized stone roads. Specifications may be obtained from the Clerk or Engineer, J. J. McKay, Home Bank Bldg., Hamilton.

Birchcliff, Ont.—Tenders will be received by C. E. Fraser, Scarborough Township Engineer, Birchcliff, until 12 o'clock

noon, Wednesday, June 21, for the construction of three reinforced concrete bridges.

British Columbia, Province of,—Contract for construction of 2,074 miles of pavement on Yale Road in Chilliwack has been awarded by Highways Department to Columbia Bitulithic, Ltd., at \$55,000.

British Columbia, Province of,—Tenders will be received by the Hon. the Minister of Public Works until noon, Wednesday, June 21, for clearing and grading portions of the Cariboo Road. P. Philip, Public Works Engineer, Department of Public Works, Parliament Bldgs, Victoria.

British Columbia, Province of,—Hon. Dr. Sutherland, Minister of Public Works, announced that the hard surfacing of the Main Street in Salmon Arm will be undertaken and a lot of macadamizing will be done beyond the limits of the municipality. Other roads will be surfaced also, and at Merritt steps will be taken to repair the One-Mile road.

British Columbia, Province of,—Tenders will be received by the Hon. the Minister of Public Works, until noon, Tuesday, June 20, for the erection of two 60-ft. span King trusses over Cheam Slough on the Agassiz-Rosedale Ferry Road. Plans and specifications may be seen at the office of Government Agent, Vancouver; District Engineer, New Westminster; and the Department of Public Works, Victoria.

Cobourg, Ont.—Town Council awarded contract for King St. paving to the Warren Bituminous Paving Co. of Ontario, Ltd., Toronto. Tenders were also received from Curran & Briggs, Standard Paving Co. and Merlo, Merlo & Ray.

Cornwall, Ont.—Tenders were received until June 12 by J. G. Cameron, Engineer of United Countries of Stormont, Dundas and Glengarry for work on roads.

East Gwillimbury Tp., Ont.—Tenders will be received, addressed to A. R. McKenzie, Queensville, Ont., until June 22, for construction of concrete bridge. Plans and specifications may be seen at office of engineers, James, Proctor & Redfern, Ltd., 36 Toronto St., Toronto.

East Whitty Tp., Ont.—Township Council passed by-law authorizing construction of the following concrete sidewalks: On west side of Park Road, 1,090 ft.; on west side of Montrave Ave., 920 ft.; on south of Base Line, 2,124 ft. Clerk, P. G. Purves, Columbus.

Edenwold, R. M., Sask.—Contracts for 40 miles new turnpiling and regrading, 30 miles very light regrading, 11,000 cu. yds. filling and 500 lin. ft. culverts, were divided amongst the following: Ross Construction Co., Regina; Henry Zinkham, Balgonia, Sask.; H. C. Siebold, Pilot Butte, Sask.; E. H. Rawlins, Balgonia, Sask.; J. Schnell, Regina. Work will be supervised by the Parsons Engineering Co., Regina.

Edmonds, B. C.—Riverway and Hastings-Barnet highways are to be improved.

Eganville, Ont.—Tenders for approximately 17,000 sq. ft. of granolithic walks will be received until July 1 by J. S. McCann, Clerk.

Eramosa Tp., Ont.—Tenders will be received by J. J. Aldrous, Rockwood, until noon, Monday, June 26, for construction of six 6-ft. culverts, 18-ft. and 20-ft. concrete bridges. Engineer, A. W. Connor, 34 Victoria St., Toronto.

Etobicoke Tp., Ont.—Tenders will be received by Frank Barber, Toronto, until 12 o'clock noon, Monday, June 19, for construction of five concrete bridges. (See official adv.).

Fonthill, Ont.—Tenders will be received by A. M. Clark, Clerk, until June 1921 for construction of 493 lin.

ft. concrete walk on Chestnut St. and 545 lin. ft. on South Pelham St.

Fort Frances, Ont.—Tenders for the construction of approximately 10,700 sq. yds. of one-course concrete pavement and for the installation of sewer and water connections as required before the construction of the said pavement, will be received by J. W. Walker, Town Clerk, until 12 o'clock noon, Monday, June 26.

Fredericton, N. B.—Roads and Streets Committee of City Council will consider extension of pavement from Smythe St. along the Woodstock Road to O'dell Ave.

Guelph Tp., Ont.—Tenders close June 20 for construction of 25-ft. concrete bridge known as Jackson Bridge, for Counties of Waterloo and Wellington. Engineer, A. W. Connor, 34 Victoria St., Toronto.

Hensall, Ont.—Tenders will be received until Wednesday, June 28, for the construction of 9,920 square yards of reinforced concrete pavement on King St. Plans and specifications may be seen at the office of T. R. Patterson, Engineer, Goderich, or A. Murdock, village clerk, Hensall, Ont. (See official advertisement).

Hamilton, Ont.—Tenders will be received by S. H. Kent, City Clerk, until 5 o'clock p.m., on Monday, June 19, for one concrete mixer. Specifications may be obtained at the office of E. R. Gray, City Engineer.

Kitchener, Ont.—City Planning Commission propose the extension of Union St., Waterloo, to Lancaster St. adjoining Bridgeport in Waterloo Township, and the extension of St. Leger St. to the Waterloo-Bridgeport Road.

Lindsay, Ont.—Granolithic walks will be constructed on Albert St. and St. Lawrence St. Clerk, W. R. Alley.

Meaford, Ont.—Town Council plans to construct Trowbridge St., from Sykes St. to the bridge, this year. Clerk, Geo. G. Albery.

Newmarket, Ont.—Town Council decided to construct pavements on Millard and Cedar Sts. Clerk, P. J. Anderson.

Newmarket, Ont.—Town Council intends to construct Warrenite bitulithic pavements on Prospect St., Park Ave., Timothy St., Church St., Millard Ave. and Lorne St., at cost of \$73,200. Town Clerk, P. J. Anderson.

New Brunswick, Province of.—Provincial Government awarded following contracts for construction of bridges: Four Mile Brook Bridge, Madawaska County, Dexter & Richards, Fredericton, \$15,000; Bass River bridge, Gloucester County, Connolly Bros., Bathurst, \$9,000; Monks (Trappist) bridge, concrete arch., Rogerville, Northumberland County, Hanson & Gammon, Fredericton, \$16,000.

Niagara Falls, Ont.—Work on the concrete abutments for the bridge over the Hydro canal on Lundy's Lane has been started by Campbell Construction Co.

Niagara Falls, Ont.—Suburban Roads Commission awarded to McRea, Campaigne & Cooke, of this city, contract for over 3½ miles of suburban road, at \$60,645.

Niagara Falls, Ont.—Chamber of Commerce awarded contract to McRea, Campaigne & Cooke for asphalt penetration at \$60,645. Other tenders received: Asphalt-Law Construction Co., Ridgeway, \$63,125; Archibald Construction Co., Toronto, \$69,000. Tar—McRea, Campaigne & Cooke, Niagara Falls, \$58,945; Law Construction Co., \$62,950; Canadian Engineering & Contracting Co. of Hamilton \$70,000.

Oliver Tp., Ont.—Township Council passed by-law authorizing expenditure of \$4,800 on roads. Clerk, Chas. R. B. Hill, Murlile.

Ontario, Province of.—Frid Construction Co., of Hamilton, secured contract to construct section of Provincial Highway on Queenston Road, east of St. Catharines city limit.

Ontario, Province of.—The highway known as St. George road, leading north out of Brantford from the end of St. Paul's road and running in a practically straight line to Gault, has been declared a county-provincial road.

Ontario, Province of.—Tenders will be received by W. McLean, Deputy Minister of Highways, until 12 o'clock p.m., Friday, July 7, for work on Provincial Highways. (See official adv.).

Orangeville, Ont.—Tenders will be received by Wheelock & Christie, Engineers, Orangeville, until 2 o'clock p.m., Monday, June 26, for construction of following bridges and culverts in County of Dufferin: (1) A 100-ft. span bridge, alternate designs of steel and concrete; (2) a bridge with 2 spans of 85 ft. each, alternative designs of steel and concrete; (3) five, 6-ft. span concrete culverts; (4) an 8-ft. span concrete culvert.

Oshawa, Ont.—Town Council plans to extend Mechanic St. Engineer, W. C. Smith.

Oshawa, Ont.—Town Council authorized Railway Committee to open preliminary negotiations in connection with the construction of a subway under G.T.R. tracks, Simcoe St. S.

Ottawa, Ont.—Tenders closed June 15 for asphalt pavements on Lyon St., Renfrew Ave., Sberbrooke St. and Breezehill. A. F. Macallum, Commissioner of Works.

Ottawa, Ont.—Tenders will be received by H. R. Washington, Clerk, Carleton County, until 12 o'clock noon, Thursday, June 15, for the substructure for Porteous and North Gower Bridges. Plans and specifications at office of Patterson & Byrne, 71½ Sparks St., Ottawa.

Owen Sound, Ont.—City Council decided to construct sidewalks at an estimated cost of \$11,500. Council also awarded contract for concrete pavement on 2nd Ave. E. to McKenzie & Symon, at \$1.83 per sq. yd. Clerk, Chas. Gordon.

Pembroke, Ont.—Tenders addressed to S. L. Biggs, Clerk-Treasurer, will be received until 12 o'clock noon, June 22, for construction of approximately 26,600 sq. yds. asphaltic concrete pavement or Warrenite-bitulithic pavement with curb and gutter. Also approximately 3,000 sq. yds. of bituminous penetration roadway with curb and gutter. Plans and specifications may be obtained at office of J. P. Howe, Town Engineer.

Quebec, Province of.—The Coaticook-Norton highway is to be built at once. Minister of Highways, Hon. J. L. Perron.

Quebec, Province of.—Following contracts have been awarded by Highways Department for the resurfacing of macadam on the Montreal-Ottawa Highway: L'Abord-a-Plouffe, Co. Laval; Kennedy Construction Co., Montreal; Ste Dorothee, D. Lagace, L'Abord-a-Plouffe; Parish of Ste. Rose, West part, D. Lagace.

Rosslyn, Ont.—Council passed by-law providing \$9,000 for road work this year.

St. Jerusalem, Que.—It is understood that two sections of road, known as the St. Jerusalem road and the Bethany road, which will form part of the Montreal-Hull highway, will be completed and fully maintained by the Provincial Government, and it was decided by the municipal council to expend \$2,000 on the gravelling of a section of the Vide Sac road, under an arrangement whereby the Provincial Government will bear one-half of the cost. A considerable amount of road repair work is being undertaken.

St. Thomas, Ont.—Reopening of Hughes St. is projected. City Engineer, W. C. Miller.

Sandwich, Ont.—Tenders addressed to W. P. Coyle, Clerk, Essex County, Sandwich, will be received until 3 p.m., Wednesday, June 21, for the construction of 2½ miles of concrete pavement on Tecumseh Road, 1¼ miles of pavement on Front Road, alternate tenders for 2 miles of concrete or tar-bound-macadam road. Plans and specifications may be seen at office of J. J. Newman C.E., Davis Block, Windsor, or at office of County Clerk. Alternate tenders for about 1½ miles of concrete, or concrete base with asphalt top, plans, etc., for which may be seen at office of Code & Code, C.E., McGregor Bldg., Windsor, or at office of County Clerk. About 1 mile of concrete pavement in Town of Essex, plans, etc., for which may be seen at office of Laird & Laird, Essex, or at office of County Engineer.

Saskatchewan, Province of.—Highways Department awarded following contracts for construction of concrete bridges: 60-ft. reinforced concrete truss, south of Drinkwater, to John Kenward Co., Regina, at \$7,778.60; 40-ft.

reinforced concrete beam bridge, east of Maple Creek, to the John Kenward Co., at \$3,901; 20-ft. reinforced concrete beam bridge, west of Yorkton, to Levi Angst, of Cypress River, Man., at \$2,072.

Simcoe, Ont.—Paving & Mastic Co., of Simcoe and Toronto, has been awarded contract for construction of town-line bridge over Patterson creek.

Sombra Tp., Ont.—Tenders addressed to John McCallum, Road Superintendent, Lambton County, Alvinston; or to John A. Huey, County Clerk, Sarnia; or to George A. McCubbin, County Engineer, Chatham; will be received until noon, Wednesday, June 28, for the completion of pavement.

Stamford Tp., Ont.—Tenders are being received at Clerk's office for construction of concrete sidewalks for 1922. Plans and specifications at Engineer's Office, Township Hall, Ferry St., Niagara Falls, Ont.

Stratford, Ont.—Tender of Curran & Briggs, Toronto, for asphalt surface paving at \$1.45 per sq. yd. was accepted by Board of Works Department.

Stratford, Ont.—Perth County Council decided to raise \$40,000 for good roads. Road Supt., John Roger, Mitchell, Ont.

Sudbury, Ont.—Town Council decided to build a 29-ft. roadway, 8-in. rock base, $2\frac{1}{2}$ tar and macadam surface, from end of the bitulithic pavement, Cedar St. bridge., to Carleton St., and along Carleton to Elm St. Clerk, W. J. Ross.

Tara, Ont.—Tenders addressed to the Township Clerk, Tara, will be received until 6 p.m., Saturday, June 17, for the construction of an arch bridge 20 ft. span on the 9th Con. of Annan between Elora Road and "B" Line. Plans and specifications may be seen at offices of Township Clerk, C. A. Speer, Tara, and of R. McDowall, C.E., Owen Sound.

Teck Tp., Ont.—Tenders will be received by C. R. Fullerton, Director, Northern Development Branch, Parliament Bldgs., Toronto, until Wednesday, June 14, for ditching the Latchford-Cochrane Trunk Road. Approximately 1,200 cu. yds. to be excavated.

Toronto, Ont.—City Council referred back the proposal to widen Jane St. to 36 ft. at cost of \$80,000.

Trafalgar Tp., Ont.—Tenders will be received by Roy F. Smith, Resident Engineer, Oakville, Ont., until 12 o'clock noon, Monday, June 26, for the construction of approximately 10,250 sq. yds. of concrete pavement. Plans and specifications may be seen on application to the Engineer, Dundas St., Oakville.

Walkerton, Ont.—Town Council awarded contract for paving road from G.T.R., station to C.P.R. station to the Warren Bituminous Paving Co. of Ontario, Ltd., Toronto, at approximately \$65,000.

Walkerville, Ont.—Following contracts were received for paving Mommouth Road, sidewalks in Willistead, alley pavement east of Lincoln and repairs corner Devonshire and Sandwich Sts.: Merlo, Merlo & Ray, \$14,270.85; Premier Construction Co., \$13,436.26; Cadwell Sand & Gravel Co., \$12,605.17. For paving Mommouth Road, sidewalks in Willistead and alley pavement east of Lincoln: Chick Contracting Co., \$13,099.32. For sidewalks in Willistead, Coloulti Bros., \$2,299.20. Contract for whole work was awarded to the Cadwell Sand & Gravel Co.

Welland, Ont.—Report will be made at next meeting of City Council on resurfacing of Bugar St. at estimated cost of \$13,000. City Engineer, Chas. L. Coulson.

Welland, Ont.—Welland County Council awarded contract for surface treatment of the road from Port Colborne to Marshville to the Bituminous Spraying & Contracting Co., Ltd., of Toronto, at \$1,115.25 per mile. There was one other tender, from the Law Construction Co. Canadian Engineering & Contracting Co., of Hamilton, was awarded contract for construction of a 9-ft. water-found macadam road in the Township of Pelham, $2\frac{1}{4}$ miles, at \$9,400 per mile. Other tenders received: John Pirson, Stevensville, \$9,979.20; McIntosh & McDougall, Cornwall, \$9,900; Roy Honsgerger Vineland, \$10,200. Law Construction Co., of Ridgeway, was awarded contract for construction of 16-ft. water-bound macadam road in the Township of Wainfleet, 5

miles, at \$15,500 per mile. Other tenders received: John Pirson, Stevensville, \$15,945.60; Geo. B. Begy, Belleville, \$19,500; and the Canadian Engineering & Contracting Co., Hamilton, \$18,500. Council adopted recommendation of Welland Suburban Roads Commission for rebuilding of 16-ft. asphalt penetration roads in this area $4\frac{1}{2}$ miles, at \$15,880 per mile, or a total of \$71,460.

Wellington Co., Ont.—Tenders will be received by James Beattie, County Clerk, Fergus, Ont., until 2 p.m., Wednesday, June 21, for the construction of bridges in the townships of Nichol, Erin, W. Garafraxa, etc.; also retaining wall. Engineer, A. W. Connor, 34 Victoria St. Toronto.

Whitby, Ont.—Ontario County Council decided to add eight miles to the county road system.

Whitby, Ont.—Ontario County Council decided to re-by-law providing for raising of \$20,000 for county roads and bridges this year.

Whitby, Ont.—Ontario County Council decided to repair several culverts, construct two new culverts and paint the county bridges. D. J. Kean, Whitby.

Whitby, Ont.—Town Council authorized issuing of debentures amounting to \$99,404 to cover expenditures connected with paving of Dundas and Brock Sts. Clerk, Albert W. Jackson.

Whitby, Ont.—By-laws will be passed by Ontario County Council on July 28 authorizing the issue of \$75,000 debentures for road construction on Provincial and county highways. Road Supt., D. J. Kean, Whitby.

Winnipeg, Man.—City Council intends to construct granolithic sidewalks on a number of streets at a total cost of \$23,505. City Engineer, W. P. Brereton.

Winnipeg, Man.—Contract for construction of granolithic walks on Argyle, Henry, Winnipeg, Owens and Greenwood Streets, was awarded by City Council to W. P. Brereton, City Engineer.

Woodstock, N. B.—Town Council plans expenditure of \$10,000 on concrete sidewalks this summer.

Woodstock, Ont.—Board of Works decided to construct curb and gutter on Oxford St. Clerk, John Morrison.

Woodstock, Ont.—Estimates of Oxford County Council for this year include the following items: County road repairs, \$30,000; county bridges, \$5,000; and Provincial Highways, \$34,805.29.

Woodstock, Ont.—Town Council intends to pave Allan St., between King and Willow; Willow, between Allan and Erb; and Erb St., from Willow to the bridge. Estimated cost, \$33,942. Town Engineer, Chas. Moogk.

Woodstock, Ont.—Town Engineer Chas. Moogk is preparing estimates on paving of John, Union and Mary Sts. Council awarded contract to Paul Bergman for curb and gutter along above-named streets at 75c per ft.

Woodstock, Ont.—Town Council instructed the chairman of Board of Works to repair King St., between William and the Kitchener boundary, and to obtain estimate on improvements to the road running north westerly from Erb St. to the Amos Weber property.

WATERWORKS AND SEWAGE

Guelph, Ont.—City Council passed by-law providing for construction of intercepting sewer from corner of Yorkshire St. and Waterloo Ave. to the city disposal plant. City Engineer, F. McArthur.

Guelph, Ont.—City Council passed by-law providing for borrowing of \$36,475 for construction of storm sewers in connection with pavements on certain streets, and another one for the borrowing of \$17,920 for same purpose.

Halifax, N. S.—Contract for 90-ton of 6-in. water pipe for city was awarded to T. McAvity & Sons, of St. John, N.B.

Hespeler, Ont.—Town Council decided to construct water mains on Victoria St. Clerk, M. E. Jardine.

Montreal, Que.—Work will be started shortly by the Public Works Department on sewers on Tallion, Paul, Desmarteau and Bernard Sts., Mercier Ward. Approximate cost, \$125,000.

New Westminster, B. C.—Plans are being made by City Engineer Stewardson for the construction of a 25-in. main to the high level reservoir.

St. John, N. B.—Provincial Hospital Commissioners decided to construct water main to Annex, Sand Cove.

Toronto, Ont.—Contracts for construction of sewers awarded as follows: To W. E. Taylor, Victoria, \$34,927; Walpole Ave., \$845. To Ruscica Bros., Small St., \$891.92.

Toronto, Ont.—Contracts for laying and jointing of 6-in. water pipes were awarded as follows: To W. E. Taylor, Alberta Ave., Brunswick Ave., Evans Ave., Fairland Ave., Forman Ave., Glenmount Park Road and Runnymede Road, \$3,272.91; Rose Park Crescent, Ruscica Bros., \$425.30.

Welland, Ont.—City Council will extend the sewer on Wilton Ave. City Engineer, Chas. L. Coulson.

Welland, Ont.—City Council let contract for construction of sewers on Queen and Margaret Streets to C. J. White, for \$1,990.80. Tender was also received from Somerville & Dilworth at \$2,088.32.

LIGHT, HEAT AND POWER

Edmonton, Alta.—Contract for supply of two induction feeder voltage regulators and two 2,000 k.v.a. transformers to city has been awarded to the Canadian General Electric Co., Ltd.

Ottawa, Ont.—Lowest tender received for lighting posts for Cummings Bridge was submitted by the Campbell Steel & Iron Works, Ltd., Carling Ave., Ottawa, and it is probable that the City Council will accept this tender.

Toronto, Ont.—Tenders addressed to Chairman, Toronto Electric Commissioners, will be received until 5 o'clock p.m., Monday, June 19, for erection of a sub-station building on Eglinton Ave., including excavation, masonry, structural steel, etc., roofing, plumbing, painting, and such other work required for a completed building. Plans and specifications may be obtained at the Engineering Department at Station "P," corner Duncan and Nelson Streets.

Winnipeg, Man.—Contract for supply and delivery of three 1,000 k.v.a. transformers complete at the city's Terminal Station Rover Ave., awarded by City Council to the Canadian Westinghouse Co., Winnipeg, at \$10,370 f.o.b. Winnipeg.

RAILWAYS

Aroostook Falls, N. B.—Contract awarded to D. C. Burpee & Son for construction of four miles of railroad for the Aroostook Valley Railway Co.

FACTORIES AND LARGE BUILDINGS

Brantford, Ont.—The erection of new \$20,000 churches for the Shenstone Memorial Baptist, Terrace Hill, and Riverdale Baptist, Holmesdale.

Cassidy, B.C.—Tenders will be received by the Hon. the Minister of Public Works until 12 o'clock noon, Tuesday, June 27, for the erection of a two-room school house. Plans and specifications may be seen at the offices of the Government Agents at Nanaimo and Vancouver; on application to the Secretary of the School Board, Wm. Eastgate, Cassidy and the Department of Public Works, Victoria.

Downtown, N. B.—Woodworking factory, warehouse, dry-sheds and other buildings owned by Henry Swim, of this place, were destroyed by fire. Loss, \$20,000.

Edmonton, Alta.—Federal Government will construct \$100,000 wing at Strathcona Hospital.

Galt, Ont.—Public School Board will likely build another ward school this summer, and will proceed immediately with the remodelling of Victoria School at a cost of \$10,000.

Galt, Ont.—Contract for carpenter work in connection with erection of factory for Newlands & Co., Ltd., has been awarded to P. G. Hamill, and the masonry work to Jas. S. Webster.

Guelph, Ont.—Tenders for erection of Brooklyn Sunday School building were received by Prof. R. Harcourt until June 19.

Guelph, Ont.—Mahoney & Austin have been appointed architects in connection with construction of new Roman Catholic chapel at the corner of Metcalfe and Alice Sts. and also for two-room addition to St. Patrick's school.

Guelph, Ont.—Tenders addressed to H. F. McNaughton, Secretary, Public Works Dept. of Ontario, Toronto, will be received until June 20 for erection of stable, barn and two cottages in connection with the Veterinary College, Ontario Agricultural College. Plans and specifications may be seen in Bursar's office at the college and at Department of Public Works, Toronto.

Haileybury, Ont.—Tenders addressed to R. A. Spencer, Secretary, Public School Board, will be received until June 22 for installation of heating system in Public School building. Plans and specifications may be obtained at the office of H. L. Slaght, chairman of Board.

Hespeler, Ont.—Town Council passed bylaw for erection of public library building. Clerk, M. E. Jardine.

Hornepayne, Ont.—Tenders will be received by M. W. Tompkins, Secretary, School Board, until June 20 for various trades in erection of a four-roomed public school. Architect, R. E. Mason, Fort William.

Kenora, Ont.—Actual work of construction of first unit of large pulp and paper mills of the Backus-Brooks Co. has started. Mr. McLellan is in charge of construction.

Kingsville, Ont.—Tenders will be received until 12 o'clock noon, June 19, by the Building Committee of Epworth Methodist Church, for supplying all materials and labor for building a Memorial Hall. Plans and specifications may be seen at office of R. Healy, Main St., Kingsville.

Lillyfield, Man.—Contract for school awarded to Johnes & Mason, Winnipeg.

Lloydminster, Sask.—Plans for 8-roomed school have been prepared by A. M. Jeffers, Architect, Edmonton, and tenders will soon be called. Estimated cost, \$50,000.

Montreal, Que.—Stockyards were damaged by fire to the extent of \$50,000.

Montreal, Que.—Permit issued to Salvation Army to construct hall on Bickerdike St., Ahuntsic Ward, at cost of \$12,000.

Montreal, Que.—Catholic School Commission awarded contract for erection of Stadacona School to Girard & Gratton, for \$126,000.

Montreal, Que.—Tenders close June 20 for excavation of basement and caissons and concrete work in foundation walls and caissons for an extension to the Head Office Building of the Sun Life Assurance Co. of Canada, at the corner of Dorchester and Mansfield Sts. Architects, Darling & Pearson, 2 Leader Lane, Toronto.

Nanaimo Bay, B.C.—Tenders will be received by the Hon. the Minister of Public Works, Victoria, until 12 o'clock noon, Tuesday, June 27, for erection of a two-room addition to the existing school house. Plans and specifications may be seen at the office of the Government Agents at Nanaimo and Vancouver on application to George Moore, Secretary to School Board, 124 Strickland St., Nanaimo or the Department of Public Works, Victoria.

Niagara Falls, Ont.—Tenders for the erection of a four-roomed addition to Falls View Public School, from all trades, will be received until 4 p.m., June 18. Plans and specifications at office of C. M. Borter, Architect, 102 Main Street.

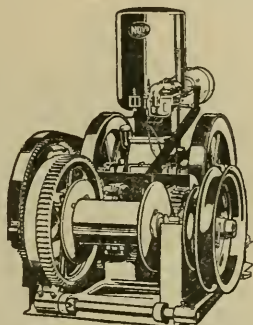
North Bay, Ont.—Contract for erection of High School awarded to Mill-Cherk-Francis, of North Bay.

North Qu'Appelle, Sask.—Debentures amounting to \$1,000 are being issued by G. M. Bushell, Secretary-Treasurer of Devon S. D. 4468, Rural Municipality of North Qu'Appelle, No. 187, for erection of school building, etc. Further particulars from the Secretary-Treasurer, Fort Qu'Appelle, Sask.

North Toronto, Ont.—New church building is to be erected at once for Davisville Baptist congregation at the south-east corner of Belsize Drive and Mount Pleasant Road, at a cost of \$20,000.

LONDON HOISTS

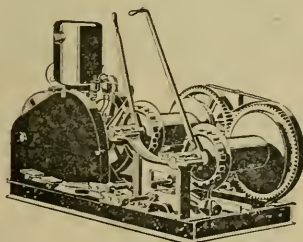
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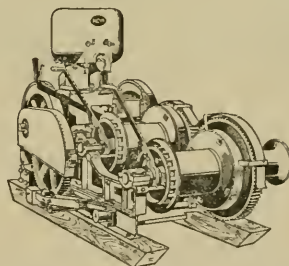
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General Supply Co. of Canada,
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HIGH PRESSURE STEEL PIPE

(FORGE-WELDED)



Large Diameter Lap Welded Pipe

Sizes 12 to 96 inches. Thickness $\frac{1}{4}$ to $1\frac{1}{2}$ inches. Lengths up to 40 feet. Galvanized or coated with the highest grade Mineral Rubber Asphalt Coating. Each length subjected to Hydraulic Test 50% greater than specified working pressure.

Specially suited for HIGH PRESSURE WATER LINES, GAS, VACUUM AND CONDENSER WORK, DREDGING AND INTAKE MAINS

Our Prices and Prompt Deliveries will interest you.

Our Production Book sent on request.

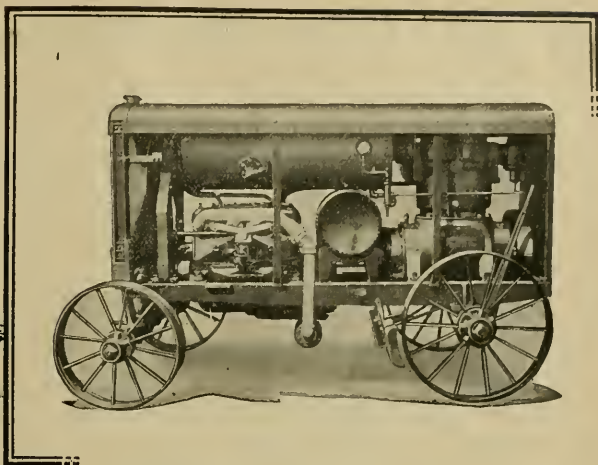
AMERICAN SPIRAL PIPE WORKS

P. O. BOX 485, CHICAGO, ILL., U.S.A.

Manufacturers of

SPIRAL RIVETED PIPE, LAP WELDED STEEL PIPE, FORGED STEEL PIPE FLANGES, EXHAUST STEAM and HYDRAULIC SUPPLIES

Use ~~the~~ Portable Compressors



"If We Only Had the Air"

You have probably said this many times when you were using hand methods on work which could have been done in a fraction of the time with air tools.

Erecting a stationary air compressor plant and piping up would have cost more than the air tools could have possibly saved—and the job was too short to take this trouble and spend the money.

An Ingersoll-Rand Portable Compressor Plant would have solved the problem. You could have rolled it up to the job, connected up the air tools, and have been finished in a fraction of the time—and with about one-half the number of men.

These Portable Compressor Plants are complete with compressor, gasoline engine (or electric motor) air receiver, cooling system and accessories. Gasoline engine driven types are built in three sizes—45, 118 and 210 cubic feet per minute. Electric motor driven types are in two sizes—45 and 118 cubic feet per minute.

When air power is as portable as a gang's tool box can you afford to work without it?

Let us send you copies of Bulletin 3315 and Forms 1062 and 1107 which tell the story in detail.

Canadian Ingersoll-Rand Company, Limited

SYDNEY SHERBROOKE MONTREAL TORONTO
COBALT WINNIPEG NELSON VANCOUVER



Ingersoll-Rand

from ore to finished product



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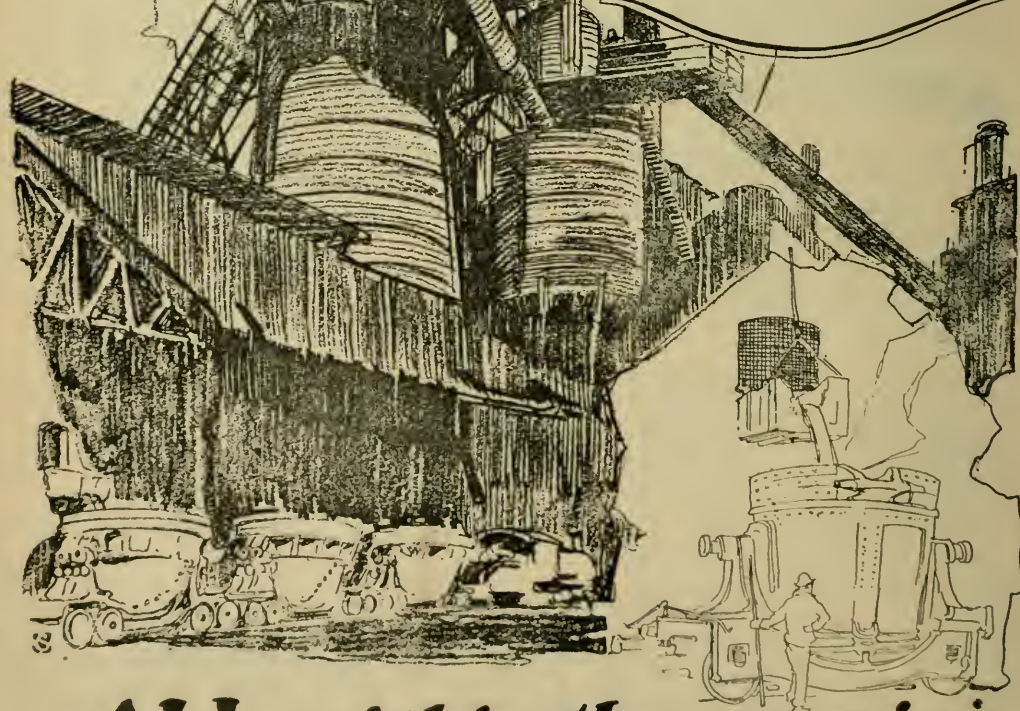
A group of vast industries commanding unlimited resources of ore, coal and other raw materials for the making of steel products of every description.

All Controlled by the

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By reason of the magnitude of the operations of our constituent companies, combined with a balanced, highly efficient organization, we are in a unique position to serve the needs of the industries of the world—and of Canada in particular.



-ALL within the empire



—yet it is within the price range for light mixers

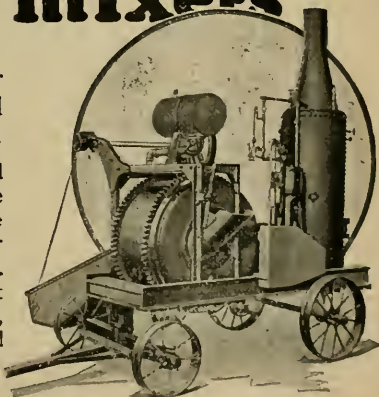
THE Dandie is a light, easily portable mixer for concrete footings, culverts, floors, and has also proved suitable for mortar mixing.

It is a Koehring mixer—Koehring designed and constructed—and this means that dependability and long service life are the first considerations, not lowest price. No it is not the lowest priced mixer, but is well within the price range for light mixers, making it the greatest *value* in light mixer field. It sets a new standard of efficiency and value for light mixers. Big production, standardization in every part, and automatic shop equipment keeps the price down!

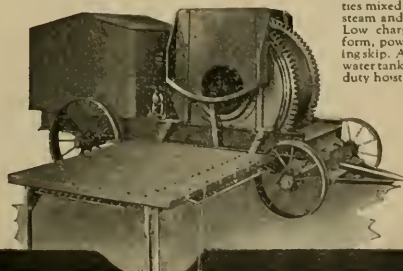
Send Today for Catalog D 27.

Get the details of construction—the liberal drum dimensions—double gear drum drive—the drum roller construction—universal bearings, mixing action—the two side discharge control—trouble-proof power—dust-proof housing. Get these details and you will see why the Dandie offers a remarkable value. Write for catalog D 27 today.

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4 and 7 cu. ft. capacities mixed concrete, steam and gasoline. Low charging platform, power charging skip. Automatic water tank and light duty hoist.





1922
Another
Neptune
Year

If Municipalities Would Only Investigate

THEY would discover that thousands of dollars required for costly new dams or reservoirs and additional pumping equipment could be saved by comparatively small expenditure for good Water Meters. Savings in water consumption from 20% to 50% can be made by installing a reliable and accurate make of water meter—and you set the "rate per thousand gallons" to meet your financial requirements.

Write us your problems—for facts and figures. No obligation of course.

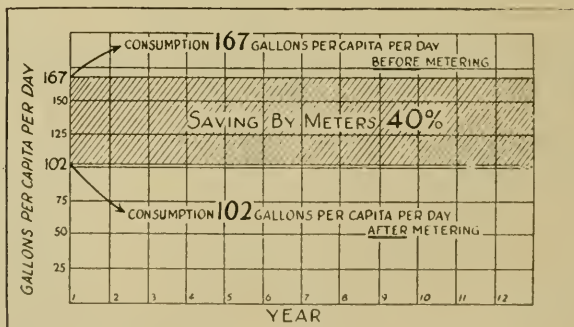
(Signed)

NEPTUNE METER CO., LTD.
Toronto, Ont.



Over
2,000,000
Trident Meters
in Use

Here's What Cleveland, Ohio, Did:



CLEVELAND reduced her daily consumption per capita from 167 to 102 gallons, making a saving of 40%, simply by the installation of water meters at a fraction of the cost of additional pumping equipment.

Neptune Meter Company, Limited

W. H. RANDALL, Managing Director

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"Pure Water Guaranteed"



In Montreal

the citizens who are supplied with water from the municipal system are protected against water-borne diseases by ROBERTS equipment, which means

"Pure Water Guaranteed"

Absolute guarantees accompany every installation of Roberts Filters, so the purchasers run no risk.

We build gravity and pressure type filters for town and city supplies, also sand and charcoal filters,—in fact filters for

every requirement — municipal and industrial.

Hundreds of "Roberts" plants have been installed throughout Canada and the United States, all of which have given complete satisfaction.

Most of the earlier filter plants in Canada were "ROBERTS-

equipped", and special attention has been given for the past twenty years to the special requirements of the Canadian field, with the result that ROBERTS filter equipment for Canadian work has been tried, tested and improved to a point where success is certain and no experimenting is needed.

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COFFIN VALVE COMPANY

Makers of the Largest Sluice and Gate Valves in America.



Photo. Courtesy U.S. Reclamation Service

At Elephant Butte Dam the U.S. Reclamation Service controls the water by four 3 ft. 11 in. x 7 ft. 6 in. Service Gates operated by hydraulic cylinders, built and installed by us.

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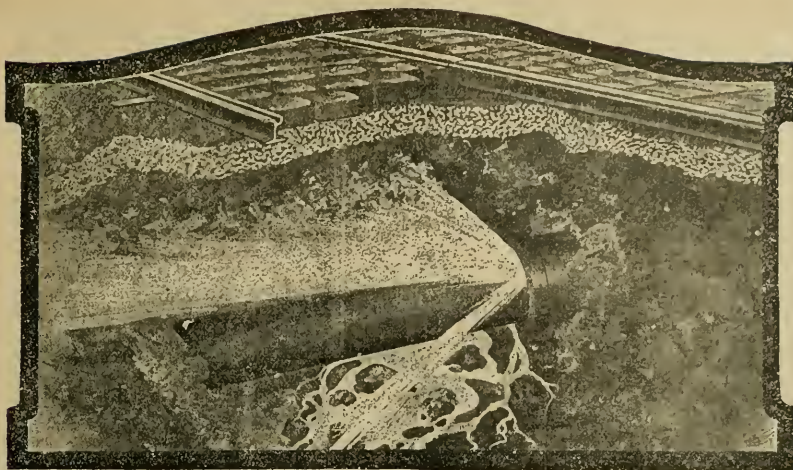
Check Valves
Flap Valves
Foot Valves
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BOSTON, MASS.,

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Philadelphia, Pa. : De Huff & Hopkins, Morris Building
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Western Representative



Are You Doing Your Share Toward Conservation?

The problems of fuel, labor and maintenance costs in waterworks seem unsolvable—and in many cases will remain unsolvable—until you take the necessary steps to eliminate waste.

It takes coal or electrical power to pump water through your mains, and coal and electricity cost money.

When all the leaks in your system are located, and the consumption reduced to a normal condition, there will be a tremendous saving, with consequent reduction in the cost of operating the pumping station.

If you are operating a gravity system, you save the cost of building new supply lines, reservoirs, etc., by stopping unnecessary waste of water.

A Pitometer Survey

in one instance showed an escape of 788,000 gallons daily. The stoppage saved an annual expense to the city of \$17,000.

We Have the Proof to Show You

Our engineers will gladly take up this matter with you and advise according to your local conditions. Let's talk it over! No charge to you for doing so and you will be under no obligation to us.

The Pitometer Company

50 CHURCH STREET, NEW YORK CITY

**PITOMETER
SURVEYS**
conserve

**FUEL,
LABOR and
MAINTENANCE
COSTS**

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Our Bulletin on GUNITE SLABS (issued in 1920) contained copies of official reports made by Prof. M. O. Fuller, Lehigh University, and Mr. George E. Strehan, Con. Eng., New York City, describing breaking tests made on slabs. On page 20 of this bulletin reference is made to a slab left for future examination. This slab, which was loaded May 7th, 1920, is 8 ft. span, 3¼ in. thick and carries a load of 440 lbs. per sq. ft.

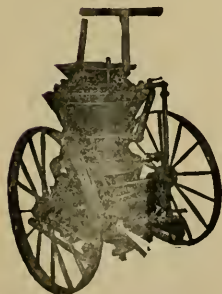
The above photograph shows this slab as it appears today, after having been constantly subjected to this overload for two years. Note that the deflection is now 2 in. and that there is no increase in the number or size of cracks at this time.

Cement - Gun Company, Inc.

New York
Pittsburg
Los Angeles

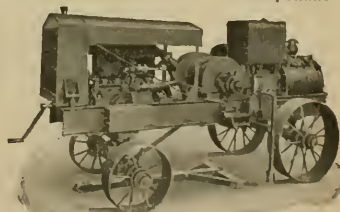
Allentown, Pa.

Chicago
Sioux City
Spokane



The "Cement-Gun" is not a restricted article. It may be purchased outright and used by anyone.

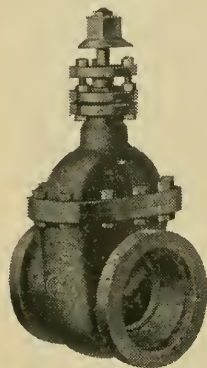
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General Supply Company
of Canada, 356 Sparks
Street, Ottawa. Branches
in Montreal, Toronto, Win-
nipeg, North Bay, Moncton.
Agents for B. C. and Al-
berta—Cement-Gun Co.,
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Cement-Gun Company, 50
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land.



Write us for information regarding the Traylor Portable Gasoline Compressor made in two sizes. Better known as the "Non-Vibrating Compressor." Especially adapted for general contractors as well as for "Cement-Gun" contractors.

Ludlow

Double Gate VALVES



1. Simple in construction—few parts.
2. No locking or wedging of gates till directly opposite port or valve opening.
3. No grinding or dragging faces of gates on seats.
4. No binding of stem in wedge.
5. No stripping thread from stems.
6. Less wear of faces and gates.
7. Work equally well with pressure on either side of gate.

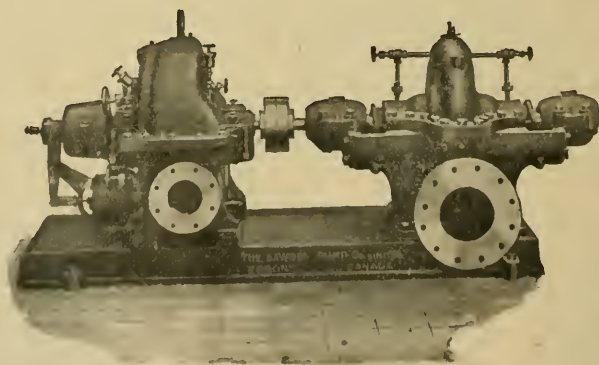
Let us tell you in detail more about the big plants and waterworks systems that are Ludlow-equipped for satisfaction.

We manufacture double gate valves, hydraulically operated valves, sluice gates, flushing gates, fire hydrants, check valves, balanced float valves, air valves, foot valves, relief valves, etc., etc.



Ludlow Valve Manufacturing Co.
Troy, New York

BAWDEN PUMPS



SIMPLICITY

STRENGTH

Type 8 Pump direct-connected to Steam Turbine

*Our pumps are made in all sizes and are surpassed by none for
EFFICIENCY DESIGN, MATERIAL OR WORKMANSHIP*

THE BAWDEN MACHINE CO., Limited—Toronto, Ont.

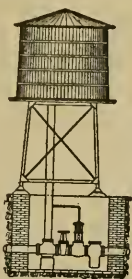
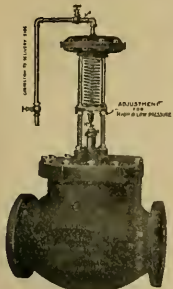
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GOLDEN-ANDERSON PATENTED CUSHIONED AUTOMATIC CONTROLLING ALTITUDE VALVES



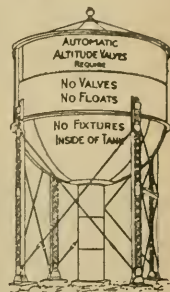
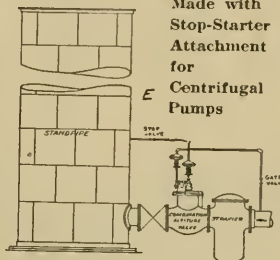
"Works Both Ways"
"Most Satisfactory"
Valves Known"

They stop all water waste down the overflows of reservoirs, stand pipes, tanks, etc., by automatically maintaining the water level constant at the desired level. They operate without floats or fixtures.

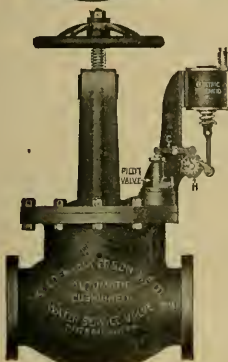
Three ways of closing:

- 1—By water.
- 2—By electricity from distant points.
- 3—By hand.

Sizes to 30 in.



Made with
 Stop-Starter
 Attachment
 for
 Centrifugal
 Pumps



Golden Anderson
Patent Cushioned-Water
Service Valve
"For Fire Service"

- 1—Can be opened and closed instantly from distant points by electricity.
- 2—Current is on only a few seconds, thereby preventing waste.
- 3—Can be fitted with either d.c. or a.c. solenoid.
- 4—Perfectly cushioned by water and air. Positively no metal-to-metal seating.
- 5—Can be closed by hand.

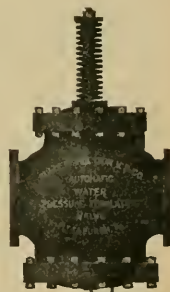
Sizes to 30 inches.

Golden - Anderson

Pat. Automatic-Cushioned
Water Pressure Reducing
Valves

- 1—Maintain a constant terminal water pressure under all conditions.
- 2—Positively cushioned by water and air in opening and closing.
- 3—Valve closes slowly, eliminating all shock and water hammer.
- 4—Can be furnished with electric feature to open valve to full area from distant points.

Sizes to 30 in.



Angle and Globe Patterns

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ESTABLISHED 1874

Boilers

Our Boiler Department is thoroughly modern. We make a specialty of Horizontal Return Tubular, and Vertical Tubular Boilers.

All Boilers manufactured according to Government uniform standard

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MISCELLANEOUS IRON WORK, FIRE ESCAPES

BOILER TUBES, SHAFTING, ETC., ETC.

THE PIONEER IRON WORKS OF WESTERN CANADA

The Vulcan Iron Works, Limited
 Winnipeg, Man.



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Under Permanent Paving



Laying Lock-Bar Pipe in Detroit, Mich.

DETROIT has installed 50,000 ft. of 48-in. Lock-Bar steel pipe. These mains run to the heart of the city.

PHILADELPHIA has just completed the installation of 15,000 ft. of 60-in. and 72-in. Lock-Bar force mains extending into the city and under permanently paved streets.

MONTREAL WATER & POWER CO. is about to instal 11,000 ft. of 42-in. and 2,000 ft. of 36-in. Lock-Bar steel pipe.

Our Handbook of Pipe will be forwarded to executives upon receipt of business card.

EAST JERSEY PIPE CO.

7 Dey St., New York, N.Y.

LOCK-BAR
STRONG AS THE PLATE ITSELF

LOCK-BAR is the PIPE with the 100 percent JOINT

Canadian Pipe Co., Ltd.

Manufacturers of Wire-Wound and
Continuous Wood Stave Pipe Silos
Wooden Tanks of every description

Write for catalogue and price

550 Pacific St.

Vancouver, B.C.

Supply Pipe built
by us for White Valley
Irrigation & Power Co., Vernon, B.C.





Under
Heavy Earth Backfill.
**Reinforced
CONCRETE
PRESSURE
PIPE,
SEWER PIPE
AND
CULVERT
PIPE**

are especially suited
to support the
Earth burden.

CANADA LOCK JOINT PIPE, LIMITED 65 PLEASANT BOULEVARD
TORONTO, ONT.

JOHNSON HYDRAULIC VALVES

WE HAVE BUILT a number of these valves for controlling the flow of water in penstocks at various Canadian plants and at present have under way in our shops the largest penstock valve of this type yet attempted. It is 20 feet in diameter, and for service under 140 ft. head at the plant of the Shawinigan Water and Power Co. We are also building several 36 inch Johnson combined stop and check valves for use in water mains of the Montreal Water Works Department.

*We also build
Paper Mill Machinery,
I. P. Morris Hydraulic
Turbines and Pumps,
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Large Gate Valves, etc.*

THE JOHNSON VALVE is built in several types to suit various conditions, and when arranged for automatic closing is a most effective protection against damage by flooding from broken pipe lines.

*Send for 1921 Bulletin containing interesting
descriptions of the various types and
their applications.*

Dominion Engineering Works, Limited

Telephone
Melrose 700

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R. F. MATHER, Western Representative, London Building, Vancouver, B. C.

Cable Address
"Domworks, Montreal"

JENKINS DISCS

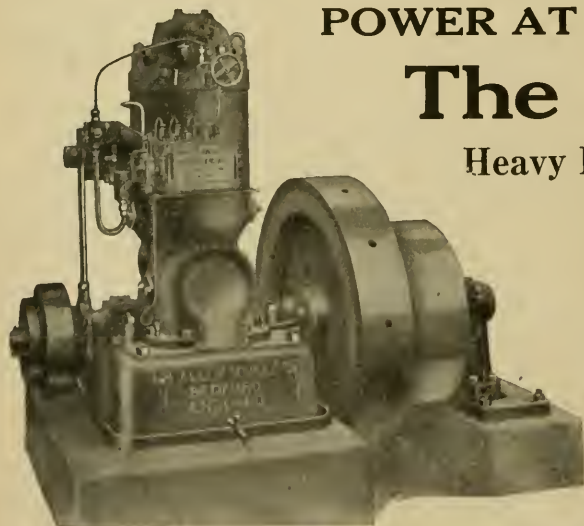
assure trouble-free valve service.

In every type of valve the disc is the part that gets the wear — the part that must be good if the valve is to function satisfactorily.

Jenkins Discs, manufactured from high grade rubber and special ingredients, stand the wear and strain because their manufacture is governed by a knowledge of what they will be called upon to do.

There's a Jenkins Valve for every service and a Jenkins Disc for every valve. Know the genuine by the Diamond Mark.

At supply houses everywhere.



POWER AT MINIMUM COST

The "Allen"

Heavy Fuel Oil Engine

for driving

DYNAMOS, PUMPS, COMPRESSORS, ETC.

Maximum Efficiency

One—Two and

Four Cylinders

Minimum Running Costs.

**Simple, Substantial and
Reliable**

**Standard sizes from 25 to 200
B. H. P.**

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The largest selling quality pencil in the world.

Engineers everywhere use the perfect VENUS knowing that none other gives the same supreme service and satisfaction.

With VENUS the fine, clean lines of working drawings are put in with ease and accuracy; the shadows and high lights of sketches take form with amazing results.

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Plain ends, per doz. \$1.50
Rubber ends, per doz. 1.75

At stationers and stores throughout the world

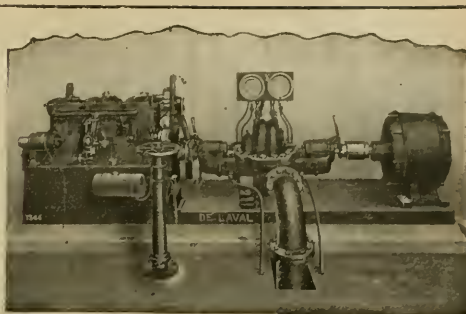
American Lead Pencil Co.
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New York

Factory:
Hoboken,
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Factory:
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Ask us about our
VENUS EVERPOINTED
Mechanical Pencil
from \$1.50 up.



Reliable Water Supply at Low Cost

For driving pumps of small and moderate sizes, particularly when placed in remote locations, electric power is often cheapest. Electric distribution systems, however, are subject to interruptions of service, as from storms, power house accidents, etc. A number of users of De Laval pumps, therefore, have insured continuity of service by installing gas or gasoline engines as "stand-bys."

The photograph shows a De Laval two-stage centrifugal pump driven by a Sterling gas engine, as installed at Lindsay, Ont. The pump is designed to deliver 1325 gal. per min. against 290 ft. head, when running at 1450 r.p.m.

De Laval centrifugal pumps have been especially designed to give regular, continuous service. All internal parts are accessible upon lifting the casing cover, and can then be lifted out after removing the bearing caps. Parts subject to wear, such as bearings, shaft sleeves, impellers, wearing rings, etc., are made to limit gages and are interchangeable. Repair parts can be obtained by giving the number which is stamped upon each part.

Their high efficiency and low starting torque are peculiarly valuable where electric power is used. All De Laval pumps are guaranteed as to efficiency, and the efficiency is demonstrated by test before the pump leaves the Works.

Describe your requirements and ask for our special Catalog B 62.

De LAVAL Steam Turbine Company

Turbine Equipment Co., Ltd., 73 King West, Toronto;
The E. Laurie Company, 233 Henry St., Montreal, Quebec;
Tayloe Engineering Co., Ltd., Vancouver.

THE WISE CONTRACTOR WORKS WONDERS

He Looks
for
This Mark
of
Quality



His
Confidence is
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Perfect
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**Wonder Mixers are Stocked and Serviced by the
Best Known Equipment Distributors in Forty Cities**

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DUNDAS STONE

Crushed Stone

Dundas Crushed Stone has the big advantage of being a tried and proven material. In miles of roadway throughout the province Dundas Stone is making good. We can give you much valuable information in this connection, if you are interested in good roads.

Write to-day.

Canada Crushed Stone Corporation, Limited

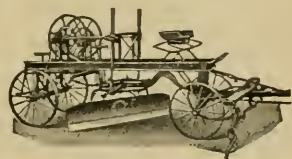
DUNDAS, ONTARIO

Toronto Agents: John E. Russell Co. Limited.
Phone Adelaide 1600

Good Roads



Do not overlook the oldest Canadian manufacturer of portable steam machinery, when you are buying machinery for making good roads. Our Hamilton works were established in 1836. We manufacture and stock a complete line of the highest grade road machinery — everything from plows to compound road rollers. Ask for our road catalogues.



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The Largest and Best Equipped
Paving and Road Building Organ-
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"WETTLAUFR HEARTSHAPE LINE IS SUPERFINE"

EVERY ONE A REAL MIXER

AND MADE IN CANADA

Endorsed by All

Our 1922 model Combination Sidewalk and Road Paver controlled by one man in one position, is commented on daily by the sidewalk and road contractors. Toronto Transportation Commission are using these mixers.

Write for catalog and special prices

Concrete and Road Machinery

Crushers, Hoists, Rolls, Pavers, Loaders,
Graders, Brick, Block, Tile, Sewer
Pipe Machines, Etc.

We equip complete plants for making
CONCRETE PRODUCTS

Wettlaufer Bros. Limited

178 Spadina Ave. Toronto, Ont.



Let's get down to brass tacks on this matter of price?

What real difference does it make to a municipality whether the engineer buys a cheap asphalt or whether he buys

MEXICAN EAGLE ASPHALT

for a few dollars a ton more?

You know that the average square yard of, say, two inch sheet asphalt pavement weighs 200 lbs. This ordinarily contains 80% sand, 10% dust and 10% asphalt cement. Therefore a square yard of pavement requires only about 20 lbs. of pure bitumen. As our asphalt is practically 100% pure bitumen, this means that one ton of 2,000 lbs. will lay approximately 100 yards of pavement. Therefore a difference of \$1.00 per ton in price means a difference of only 1 cent per square yard in the cost of the pavement!

Full information and samples upon request.

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SOLE CANADIAN AGENTS FOR THE MEXICAN EAGLE OIL CO LIMITED
BOARD OF TRADE BUILDING - MONTREAL



Centrifugal Pumps

SEMI-DIESEL OIL ENGINES

Write for prices and literature

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AND COMPANY LIMITED

STEEL MANUFACTURERS
SHIPBUILDERS

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Canadian Good Roads Convention at Victoria

Most Successful Meeting — Delegates From All Parts of Canada Evince Great Interest in Good Roads Movement — Valuable Technical Papers Read Dealing With Road Construction Problems — Sessions Well Attended

(Staff Correspondence)

FROM the Atlantic to the Pacific, cabinet ministers, members of parliament, engineers, and prominent business men from every province of the Dominion, arrived at Victoria during the week-end to attend the Ninth Annual Convention of the Canadian Good Roads Association, which was held at the Empress Hotel, Monday, June 12 to Thursday, June 15. The large avenue of welcome banners with the light standards festooned with golden broom. The profusion of bloom in the gardens of the Parliament Buildings and of the Hotel presented a striking and charming appearance, and the delegates were conscious of an air of welcome on every hand.

Morning Session, Monday

The opening session was devoted chiefly to the registration of delegates. Addresses of welcome were given by Premier Oliver, Hon. E. D. Barrow, Hon. W. H. Suther-

land, Hon. A. M. Manson, Acting Mayor J. Harvey, J. L. Beckwith and by representatives of the local clubs and organizations. The addresses were suitably acknowledged on behalf of the association by S. L. Squire, a past president, and the present chairman of the executive committee, who referred to the bright prospects for a successful meeting, and the

future of the association evinced in the large number in attendance. Every province in the Dominion was well represented, as well as many states in the Union, all of whom had assembled for the exchange of views and the discussion of problems of vital interest to national development. Unusual interest attached to the very excellent programme arranged by the executive committee.

Afternoon Session, Monday

The opening address was given by the president of the association, Hon. S. J. Latta, Minister of Education for Saskatchewan, who dealt chiefly with the human element



HON. J. L. PERRON
President, Canadian Good Roads Association



HON. S. J. LATTA
President, Canadian Good Roads Association



RUSSELL T. KELLEY
First Vice-President, Canadian Good Roads Association

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The addresses were suitably acknowledged on behalf of the association by S. L. Squire, a past president, and the present chairman of the executive committee, who referred to the bright prospects for a successful meeting, and the

as a factor in Canada's development. Mr. Latta's address in a concise manner covered a wide field, and touched on nearly all the legislative, engineering and economic problems of the road builder. Running through it all, however, was the argument that the possession of great wealth in natural resources such as Canada enjoyed, would not of itself, bring greatness to a nation. Those conditions must

also be secured which promote happiness and contentment. He pointed out that the best results would be accomplished by the association in proportion as its members promoted all the interests of all localities of this great land, and that the greatest good will come to each unit when the greatest good comes to all.

Mr. Latta suggested the following points as being worth consideration. The greatest good to the greatest number, most direct route possible for traffic, avoidance of sharp curves, advantage of easy grades, minimum construction cost, economy of maintenance, correlation of each road selected and located to all other portions of the whole system, relation of the road as a feeder to the railways, drainage facilities, proximity of road material, future requirements, necessity for bridges and culverts, money available for the project proposed.

The advantage of careful scientific planning could not be over-estimated. A well-planned road system would help build up manufacturing industries; reduce the cost of living by bringing rural residents within closer reach of the urban dwellers, help attract settlement and elevate social life of the community.

Road building is a great co-operative enterprise. Tax-payers of any given community should co-operate with each other in the interest of all. The distribution of funds depends on the ability to contribute and the benefit derived from the utility provided. Provincial aid to the communities ought to be given on the same basis. It is quite evident that a basis of population may not fulfill all requirements of the purpose of co-operation. In like manner it may easily be shown that distribution of federal aid among provinces on a population basis may be, in many respects, unjust and inequitable.

Emphasizing the magnitude of the road building problem, the president instanced the relatively small population spread over an immense area. Upon a family of four persons, less than the average, rests the enormous responsibility of building and maintaining one mile of roadway and upon five average families the construction and maintenance of a mile of main market highway.

Before more railways are built or extended, land areas must be examined and found fit to serve the human element. Scientifically planned road systems ought to be devised so that railways, roads and economical value of land may be made fit in with each other.

Prof. K. A. Clark, of the University of Alberta, presented an interesting paper, which appears in this issue, on "Experiments in Improving and Maintaining Prairie Roads." Prof. Clark has been conducting some research in the treatment of soils, the object being to discover a method by which natural ingredients of the prairies could be treated or combined to secure greater stability. While he stated that the idea was not entirely new, he had succeeded in getting encouraging results, and demonstrated that by recovering bituminous oil from the Alberta tar sands, he had combined this oil with the natural wet soils and obtained as a result, a hard non-absorbent substance capable of resisting relatively high pressure. Further results of Prof. Clark's experiments will be awaited with deep interest, especially by those in the prairie provinces.

H. R. MacKenzie, chief field engineer for Saskatchewan, read a paper on the "Drainage of Prairie Roads," and in a lucid manner set forth the problems met with and the methods adopted, to meet the conditions peculiar to the prairies. This paper appears in another part of this issue.

Germain P. Graham, of Albany, N.Y., district engineer of the Asphalt Association, gave an illustrated talk on the use of asphalt for road building. Mr. Graham showed 30 slides and 2 films of moving pictures, giving details of plant and methods for the construction of penetration and asphaltic concrete roads. Also for surface treatment and black base foundation. The films shown by Mr. Graham were the property of the Bureau of Public Roads, Washington, D.C., and were much appreciated. Mr. Graham explained each slide and the various steps in construction as shown in the films.

At the conclusion of the afternoon session the reception committee took the delegates by motor to the many interesting and scenic points of the city, and in the evening entertained them with a most unique and enjoyable theatre party.

Morning Session, Tuesday

The presiding officer for the morning session was J. A. Duchastel, chief engineer of Outremont, Que., and the first address was given by A. W. Campbell, Commissioner of Highways for the Dominion Government, who dealt with "Federal Aid, Its Implications and Results." This paper appears in another part of this issue. Much interest in the subject was taken, and in discussion, the British Columbia delegates made a strong plea for extra consideration in view of the greater natural obstacles which had to be overcome in that province. This view received some support from the delegates from eastern provinces.

A very interesting paper was read by J. D. Robertson, Deputy Minister of Public Works of Alberta, on "How to Improve Earth, Clay and Sand Roads. This paper appears on another page in this issue.

The difficulties confronting the road builders of the prairie provinces were clearly set forth. The enormous mileage cared for, and the scarcity of suitable materials, compels the engineer to adopt methods rather novel to those from the other provinces. Every effort is made to utilize the surface soil, including sods and turf, as these afford a sort of fabric giving greater stability to the surface. Much of the construction is done by the use of the grader, drawn by a heavy tractor.

A feature of the afternoon session was an eloquent plea for better roads as a nation-building force, by A. P. Sandles of Columbus, Ohio. He warned against the construction of costly highways and said that the patrol and maintenance were the secrets of good roads. The progressive way to regard the question was not from the point of taxation, but from the standpoint of benefits derived.

Hon. J. L. Perron, of Quebec, Minister of Highways for the province, in the afternoon outlined Quebec's road policy since 1912. He declared that the program inaugurated in 1912 was now practically completed and that by next August there would not be a mile of road in the province that was not in first class condition. He said about \$8,500,000 would probably be expended on roads for the present year. Quebec spent \$1,000,000 on roads in 1912.

James Allen, supervisor of State Highways of the State of Washington, presented an excellent paper, which appeared in June 20 issue of "The Canadian Engineer," on "Cement Concrete Roads," as adopted in that state. In Washington this type of construction is the only one used for rigid surfaces, and has given great satisfaction from the standpoint of construction, maintenance and durability. The paper was ably discussed by A. E. Foreman, Western representative of the Portland Cement Association.

A number of interesting points were brought out in a paper on "Road Machinery," by F. L. MacPherson of the Department of Public Works, Victoria, B.C. He pointed out the necessity of the road engineer being versed in matters relating to the mechanical engineer. The care, maintenance and repair of all mechanical equipment are essential to the efficient working of a road builders' outfit.

Election of Officers

The afternoon session was brought to a close by the election of officers for the ensuing year as follows:

Hon. president, Hon. S. J. Latta, Regina; president, Hon. J. L. Perron, K.C., Montreal; first vice-president, R. T. Kelley, Hamilton, Ont.; second vice-president, F. L. Fel-lows, Vancouver, B.C.; secretary-treasurer, G. A. McNamee, Montreal; directors, Jos. Beaubien, Outremont, Que.; H. S. Carpenter, Regina; Wm. Findlay, Toronto; Geo. Hogarth, Toronto; J. D. Robertson, Edmonton; P. Phillip, Victoria; S. R. Henderson, Winnipeg; G. F. Pearson, Halifax; R. D. Patterson, St. John; A. M. Rankin, M.P.P., Collins' Bay, Ont.; T. J. Mahoney, Hamilton; H. H. Shaw,

Charlottetown; P. J. A. Duchastel, Outremont, Que.; P. Gommery, Vancouver; R. H. Murray, Halifax.

During these sessions the ladies were very graciously entertained by the women's organizations and given opportunities of visiting all the points of interest, one of the chief functions being a reception and musicale in the hotel parlors, given by the Women's Canadian Club.

gainst motor and highway alike. He urged the adoption of regulations requiring each truck to be stamped in large letters with its capacity in tons, and the punishment by law of all who exceed the limits.

A limited number of the delegates were the guests of the Canadian Automobile Association at luncheon, at which Dr. Doolittle presided, the guest of honor being His Honor



GEO. A. McNAMEE
Secretary-Treasurer, Canadian Good Roads Association



G. FRED PEARSON
Director, Canadian Good Roads Association



WILLIAM FINDLAY
Director, Canadian Good Roads Association

An informal reception was given to the delegates by His Honor, the Lieutenant-Governor and Mrs. Nichol, and an enjoyable evening was spent.

Wednesday Morning Session

The morning session opened promptly with S. R. Henderson, president of the Manitoba Good Roads Association, in the chair.

P. Philip, engineer of the Department of Public Works for B.C., in a brief but comprehensive manner, outlined the system in vogue in British Columbia and stated that by a progressive system they were gradually linking up the various settled sections by a system of trunk roads which would ultimately form part of an all-Canada trans-continental highway. Governmental classification and systematic supervision by expert engineers, he stated, were securing higher efficiency, and that the only roads they were constructing were good roads.

Mrs. Mary Ellen Smith, M.P.P., took part in the proceedings, pointing out the great natural difficulties to be met with in British Columbia. She spoke of the value of the East meeting the West by means of a Canadian National Highway and propounded the slogan "See Canada by Motor Car."

The subject of colonization roads was dealt with by W. F. Fullerton, Superintendent of Colonization Roads for Ontario. He pointed out the necessity for taking the utmost care in the location of all colonization roads, and for generous treatment of such districts. Settlement in new areas, he stated, was irrevocably bound up with road construction.

"The Maximum Weights, Speed and Width of Tires, etc., of Motor Trucks," was the subject of a paper given by C. W. Cornell, manager of the White Co., Seattle, Washington. This paper will appear in an early issue of "The Canadian Engineer." The speaker laid stress on the value of pneumatic tires in prolonging the life of rigid surfaces, and condemned the practice of overloading, as a crime a-

gainst the Lieutenant-Governor. After toasts to the King, and the President of the United States, short addresses were given by His Honor Mr. Nichol, and by Mr. Sandles of Columbus, Ohio.

Wednesday Afternoon Session

T. J. Mahoney, past president of the Ontario Good Roads Association, occupied the chair and introduced as the first speaker, Hon. John P. Hartman, of Seattle, Washington, who's paper will shortly appear in "The Canadian Engineer." Mr. Hartman's subject was "Permanent Highways," and in his inspiring address he laid stress on the necessity of organizing the present economic position of the farmer, and incidentally affording adequate means to transport his produce to the consuming public. He said that the old idea of the farmer was obsolete, and that the coming in of the all-year-round passable highway with free rural mail delivery has put the farmer close to the market and with his daily papers, his daily market reports and a quick receipt of the best magazines and papers, he now has become one of the best posted classes of the whole country.

Mr. Hartman pointed out that the modern all-year road wherever it has been built has robbed the railway of practically all the well-paying short-haul freight, and that the establishment of gasoline vehicle lines was doing much to bring about a healthy back-to-the-farm movement. Putting his finger on one of the major handicaps of modern business, he declared that the trouble throughout the Dominion and the United States is that the freight rate is too high, having not yet been reduced from the rate induced by the war, and while admitting that good highways take away some of the business of the railways, Mr. Hartman said that the railroad would in the end reap its full reward if husbandry was properly fostered.

The next speaker was J. A. Duchastel, manager and city engineer of Outremont, who dealt with the subject of "Foundations." In a clear and concise manner he pointed

out the importance of so beginning the work of road building as to the substructure that that portion of the road will not require construction where the surface wears out. In other words the base should be of a most permanent character particularly on all hard surfaces, and so related to the surface that the latter can be renewed from time to time as it wears out, without disturbing the former.

During the afternoon another contingent from Ontario arrived, in the persons of the Premier, the Hon. E. C. and Mrs. Drury, the Hon. F. C. and Mrs. Biggs, Minister of Public Works, W. A. McLean, a past president and now deputy-Minister of Highways of Ontario, and others. As to the popularity and attendance the crowning event of the convention was the banquet held in the beautiful hall of the Empress Hotel. The setting with the abundance of golden broom and other flowers, for which Victoria is famous, was charming and the entertainment provided by the committee was delightful.

At the head table were seated, among others, His Honor the Lieutenant-Governor Walter C. Nichol, Premier John Oliver, Premier E. C. Drury, Hon. J. L. Perron, K.C., the president-elect of the association, and other notable leaders in the good roads movement in Canada and the United States.

Banquet

Over three hundred guests sat down and the Hon. S. J. Latta, the retiring president, presided as toast-master. After the toast to the King, Mr. Latta, in a very characteristic and eloquent manner, delivered the speech of the evening, and said, in part: "Propaganda for good roads is justified not alone by economic reasons, because good roads will make it easier for all of us to make a living, but because the building of good roads is one of the greatest socializing things we can strive for. Probably we in the interior provinces can appreciate these influences better than you can in British Columbia, but on the prairies we have scores of races represented in the population, men and women with different ideals, different view points, and different methods of living; and by prosecuting our good roads propaganda we are bringing these people together and giving them a common ideal and purpose that will make for a greater and better Canada. Good roads, by making all our people neighbors and better friends, are building for us a consolidated national settlement."

The Lieut.-Governor, W. C. Nichol, welcomed the delegates to British Columbia. We in this province have our own problems and anxieties, said Mr. Nichol. We are working in our own way to make this a greater province. The comparative harmony we enjoy in this work indicates that the real heart beats true, and we believe that ultimately this province will be regarded as one of the greatest outposts of the British Empire.

The toast to "Our Governments" was replied to by Premier Oliver and Premier Drury. Mr. Oliver commended the Good Roads Association for the service it was rendering in making known the highway needs of the country and spreading information on the subject. He agreed with Mr. Latta as to the importance of welding together the diverse interests of Canada and stated that if all the good qualities of the various races represented are to be welded together, there must be a welding flux, that flux is equity, truth and justice, and the application of the Golden Rule in government. Premier Drury referred to the Good Roads Association as an agency of international value because of its influence in bringing together the forward-looking people of the United States and Canada, and declared that the most important thing in the world is the continuance of friendship between the Anglo-Saxon nations. We have built on one foundation and we have one set of ideals to give the world. Mr. Drury told how in Ontario the government had sought to build roads so as to adequately serve the needs of all elements of the population. Some are either apathetic or opposed to the movement, others are so urgent that they want a road built over night and in addition to these there is the question of costs which gives those responsible much to worry about. The province, he

said, assumed the cost of roads carrying through traffic while the municipalities with government aid paid for the roads of a local character. The motor license fees went a half to financing and a half to the cost of maintenance. He believed, he said, in progress, but in sane progress. There can never be roads that are too good, but we know too well that there can be roads that cost too much.

The toast to Canada was fittingly replied to by the Hon. J. L. Perron, the president-elect, who, in an eloquent manner paid a high tribute to the entertainment committee.

A. P. Sandles made an appropriate reply to the toast to the United States, and eulogized the work of the executive, laying special stress on the work done by Mr. Squire and by the secretary, Mr. McNamee.

"The Press," was responded to by Mr. Nichols, editor of the Victoria Times, who expressed his sympathy with the aims and objects of the association and congratulated the members on an interesting and successful convention.

Ald. R. W. Perry responded for "The City," in a very hearty manner, and hoped that the delegates would all soon come back to stay.

Mrs. R. Baird and Mrs. H. Briggs with Mrs. A. J. Gibson, delighted the gathering in song, while sing-songs were led by Mr. Webb and Mr. Killey.

The Empress Hotel Orchestra rendered selections which were enjoyed by all.

During Thursday and Friday, by the generous arrangements of the entertainment committee, the delegates were taken on sight-seeing tours. The grandeur of the far-famed Butchart Gardens will never be forgotten. They so far exceed even the imagination that one would not attempt to describe them. Added to this was the cordial hospitality of Mr. and Mrs. Butchart, which was entirely in keeping with the scene. The scenic beauty of the renowned Malahat Drive, known to all motorists of the coast, was greatly enjoyed, and the visitors received an impression as to the beauties of the island, its rich and productive soil, and above all its delightful and hospitable people that will linger long in the memory.

Thursday Morning Session

The morning session was opened promptly by Hon. G. S. Henry presiding. The first paper was read by John S. Crandell, consulting engineer of the Barrett Co., New York City, on "Roads and Pavements for Average Conditions." This paper will appear in a near-by issue of "The Canadian Engineer." The other paper read at the morning session was on "Road Dragging and Maintenance Competitions," by Hon. H. S. Carpenter, Deputy-Minister of Highways, Province of Saskatchewan.

The papers scheduled for the afternoon session were taken as read in order to allow the delegates to participate in a motor tour of the Saanich Peninsula and a visit to Butchart's Gardens. The addresses presented at the close of the convention were by A. S. McMillan, superintendent of highways for Nova Scotia, who dealt with construction of bridges and culverts; William Findlay, of A. McKim, Ltd., Toronto, whose paper was devoted to methods of financing road construction, bonding and revenue.

With the conclusion of the business of the Association, many of the out-of-town delegates started on their homeward journey, although a considerable number remained in Victoria a day or so longer. The convention was most satisfactory from every point of view. The subjects discussed were most interesting to those connected with highway construction. The spirit which pervaded every session was most delightful and profitable and it was left by all who attended that it was the best convention ever held.

The following resolutions were among those presented at the Thursday morning session by the Committee on Resolutions:

RESOLVED: That this Association re-affirm its approval of the principle of Federal aid, the Provinces of the Dominion having undertaken comprehensive road policies because of Federal aid, and as improved roads are a great national asset, and have a direct and definite relationship to agriculture, immigration, colonization, and transporta-

tion: and since these are of great importance to Canada as a Nation, the Federal Government is justified in continuing financial assistance to the Provinces in the building of all main or through roads, and that any Province, at the expiration of the time limit set forth by the present act respecting "Federal Aid," which may not have been able to take full advantage of the allotment for that particular Province, owing to labor and financial conditions, shall be entitled to an extension of time. Such extension shall not interfere with any future Federal assistance.

RESOLVED: That this Association go on record as approving the principle of provincial autonomy in matters of road building;

(1) That in the selection of routes or of roads to be improved same to be made with the following in view:

(a) Local service.

(b) Eventually co-ordinating the roads within the province that the system when completed, may form a comprehensive whole and that Inter-Provincial Roads be made a part of such plan.

(c) That roads be built economically, and of such standard or type as may best meet the traffic, which they must bear.

(d) That roads when improved, shall be maintained.

Delegates at Convention

The following is a list of delegates attending the Good Roads Convention:

James Allen, supervisor highways, Olympia, Wash.; F. H. Auld, Deputy Minister of Agriculture, Regina.

James R. Agar, president New Westminster Auto Club; F. W. Anderson, M.P.P.

Robert Bremond, Toronto; C. Brakenridge, consulting engineer, Vancouver; H. Frank Bird, secretary Good Roads Association, Vancouver; Hon. E. D. Barrow, Minister of Agriculture; J. T. Brandon, secretary S. P. C. A.; John Blue, secretary Edmonton Auto Club, Edmonton; J. C. Brady, district engineer, B. C. Department Public Works.

town, P.E.I.; Senator O. H. Colfox, Washington; R. H. Cameron, Toronto; C. E. Cartwright, civil engineer, Vancouver; J. O. Cameron, Cameron Lumber Co.; H. H. Cook, Toronto; M. P. Cotton, Engineers and Contractors, Vancouver; Prof. K. A. Clarke, research engineer, University of Alberta, Edmonton; J. R. Colley, third vice-president, Good Roads Association, Kamloops; A. L. Carruthers, district engineer, Provincial Department of Public Works, Prince Rupert; A. J. Clark, Vancouver; H. S. Carpenter, Deputy Minister of Highways, Regina; A. W. Campbell, Dominion Commissioner of Highways, Ottawa.

Hon. E. C. Drury, Premier of Ontario, Toronto; James Duncan, municipal engineer, Holyburn, Vancouver; R. G. Davidson, Portland, Oregon; A. Dixon, district engineer, Department of Public Works, South Fort George; A. J. Donahue, president of Alberta Association of Municipal Districts, Calgary; Dr. P. E. Dochittle, president Auto Association, Toronto; W. J. Dawson, manager, Gutta Percha Rubber Co., Winnipeg; J. A. Duschastel, chief engineer and manager, Outremont, Que.

W. H. Easterbrook, chairman Roads Committee, Wentworth County, Aldershot, Ont.

W. G. Fowler, manager, Gutta Percha Rubber Co., Vancouver; R. Fenton, Calgary; A. E. Foreman, district engineer, Portland Cement Association, Vancouver; T. H. Fellows, district engineer, Vancouver; F. W. Farness, Superintendent of Works, New Westminster; J. A. Flanagan, Conservation Commission, Malone, New York; J. P. Forde, district engineer, Department of Public Works of Canada, Victoria; J. W. Finlayson, Prof. C. E. ManiFullerton, Supt. Roads, Toronto.

W. K. Gwyer, district engineer, Penticton; W. B. Greig, Point Grey; W. A. Gourley, engineer, Canada Highways Commission, Victoria; R. H. Gale, president Good Roads Association, Vancouver; Percy Gomery, Vancouver; E. R. Gilley, engineer, Gilley Bros., New Westminster; Professor



R. H. MURRAY

Director, Canadian Good Roads Association



S. L. SQUIRE

Past President, Canadian Good Roads Association



GEO. HOGARTH

Director, Canadian Good Roads Association

Cranbrook; H. H. Bigwood, chief draughtsman, Public Works Department; Col. John Balcharrle, Ottawa; J. W. T. Blackman, city engineer, North Vancouver; Hon. F. C. Biggs, Minister of Public Works, Toronto.

J. W. Cunningham, treasurer Good Roads League, New Westminster; J. K. Clark, Supt. Expt. Station, Charlotte-

ville, N.Y.

C. B. Huyck, manager Mussen's, Ltd., Vancouver; Col. A. E. Hodgins, district engineer, Victoria; Hon. John P. Hartman, Seattle, Wash.; Geo. L. Henry, Todmorden, Ont.

Frank Hobbs, Cadboro Bay; R. K. Houlgate, president Vancouver Board of Trade, Vancouver; J. H. Hodgson, Wentworth Suburban Highway Commission, Hamilton; J. B. Harkin, Commissioner of Dominion Parks, Ottawa; S. R. Henderson, president Manitoba Good Roads Association, Winnipeg; Alderman Harvey; L. B. Howland, vice-president C.A.A., Pasadena, California; J. B. Holdcroft, Victoria; Hon. George S. Henry, Toronto; John Haddon, president Manitoba municipality, Winnipeg.

David W. Johnston, municipal engineer, South Vancouver; John B. Jardine, New Westminster; P. J. Jennings, Assistant Commissioner of Irrigation, Department of Interior, Calgary; J. H. Johnson, Burbrook, Ont.; W. J. Jackman, Bremner, Alta.

R. T. Kelley, first vice-pres., Good Roads Association, Hamilton; C. E. Kendall, Rep. Watrous Engine Works, Vancouver; Fraser L. Keith, Secretary Engineering Institute of Canada, Montreal.

Hon. S. J. Latta, Minister of Education, Regina, Sask.; Prof. A. T. Laing, Professor Highway Engineering, Toronto University, Toronto.

W. L. Macken, president Associated Boards of Trade, Chilliwack; G. T. Maurice, Inspector S.P.C.A.; H. B. MacKenzie, highway engineer, Public Works; G. C. MacKay, district engineer, P.W.D., Quesnel; Hon. A. M. Manson; J. A. McIver, Reeve of Maple Ridge Municipality, Port Hammond, B.C.; Chas. A. Mullen, consulting engineer, Montreal; Prof. E. G. Matheson, Professor of Civil Engineering, University of B.C., Vancouver; T. J. Mahoney, Chairman, Hamilton Highway Commission, Hamilton, Ont.; F. L. Macpherson, B.C.P.W. Department, Victoria; J. B. Moon, Vancouver; Geo. A. McNamee, Secretary-Treasurer, Canadian Good Roads Association, Montreal; Geo. McNamee, Jr., Outremont, Montreal; H. J. Mackay, Ashcroft, B.C.; J. M. McCutcheon, Toronto, Ont.; A. F. MacCallum, Commissioner of Works, Ottawa; W. A. McLean, Deputy Minister of Highways, Toronto.

Nels Nelson, New Westminster, B. of T.

Hon. John Oliver, Premier of British Columbia, Victoria.

Wm. Pearce, Department of Colonization and Development, Calgary; G. Parkinson, Port Renfrew, B.C.; H. M. Pugsley, Richmond Hill, Ont.; Guy Perron, Montreal, Que.; Patrick Phillip, Public Works Engineer, Victoria; W. E. Payne, Secretary Vancouver Board of Trade; Hon. J. L. Perron, Minister of Public Works, Montreal.

C. M. Rolston, Vancouver; Chester Reitze, assistant general manager, Portland Cement Association, Seattle.

S. S. Rose, Brantford, Ont.; A. A. Ross, Vancouver; W. G. Robertson, Sec.-Treasurer, Ontario Motor League, Toronto; F. R. McD. Russell, vice-president Pacific Highway Association, Vancouver; A. M. Rankin, Collins Bay, Ont.; D. M. Roy, Dunlop Rubber Co., Toronto; T. Rogness, resident engineer Road Association, Fernie, B.C.; J. D. Robertson, Deputy Minister Public Works, Edmonton, Alta.; Wm. Ramsay, district engineer, Department of Public Works, Nelson; Hon. Alex. Ross, Minister of Public Works, Edmonton, Alta.; F. Lorne Roe, Good Roads League, Penticton; J. T. Robinson, Kamloops.

S. L. Spilre, Chairman Executive Good Roads Commission, Toronto; J. Scott, Manager Dunlop Rubber Co., Vancouver; A. P. Sandles, Good Roads U.S.A., Columbus, Ohio; Fred J. Spalding, Commissioner Tourist Association, Fernie, B.C.; Harry Stewardson, city engineer, New Westminster; Roy Sweeney, Kelowna Auto and Good Roads Association, Victoria; Hon. W. H. Sutherland, Minister of Public Works, B.C.

G. W. Turnroos, civil engineer, Vancouver; L. Netta Turnbull, Vancouver; Jack Turgeon, Montreal; Thos. H. Tracey, Vancouver; Frank Terrace, Good Roads Association, Orillia, Ont.; E. Tomlin, B. C. Cement Co., Victoria.

H. S. Van Scoyoc, Canada Cement Co., Montreal; E. H. Verner, district engineer, P.W.D., Port Coquitlam; Thos. W. B. Vermand, Ontario Motor League, Toronto; E. R. Vigor, Vancouver.

L. Wright, Hamilton Chamber of Commerce, Hamilton, Ont.; Geo. H. Webster, Calgary; G. B. Whitehead, district engineer, B. C. Public Works, Kamloops, B.C.; J. M. Wardell, chief engineer, Canadian National Parks, Ottawa; Frank G. Woodside, Vancouver; Fred L. Wolf, State Representative, Newport, Wash.

A. A. Young, engineer, Winnipeg.

B.C. FOREST PRODUCTS BUREAU

WITH M. A. GRAINGER as secretary and manager, the Forest Products Market Extension Bureau of British Columbia has been organized by the lumber and shingle interests of that province. Offices have been opened in the Metropolitan Building, Vancouver. Following is the Bureau's general outline of its proposed activities:

1—Investigation of new markets which are now opening up for British Columbia products, such as the Japan market.

2—Assistance to salesmen and manufacturers by practical work in existing markets, such as the four-billion foot market for shop-grade lumber in the wood-using industries of the East and Middle West, in which British Columbia material as yet has hardly gained a footing.

3—Making the value of British Columbia products known through general publicity, exhibits, pamphlets and personal work of field men among buyers, contractors, architects, railroads and other large users of wood.

4—Combating propaganda aimed by steel, concrete and roofing substitutes against wood products; opposing anti-shingle legislation and securing just treatment of Western woods in city building codes.

5—Advising manufacturers regarding desirable changes in character of output to take advantage of new lines of market demand, and regarding possible improvements in selling methods. Assisting the movement for better standardization.

6—Compiling practical information for both producer and consumer and maintaining a prompt news service regarding trade openings.

7—Assisting timberholders by studying market possibilities so as to make closer utilization of stumpage practicable, as for instance by strengthening the demand for West Coast hemlock.

8—Educational work around logging operations to promote the most profitable cutting of logs for grade and length.

Applying a coating of concrete by the method known as "Gunlite" consists of projecting a fine spray of cement combined with water, and a high pressure from a special apparatus, the "Cement-Gun." From tests applied by the University of California as to the rusting of steel in concrete, it would appear that "Gunlite" possesses certain acid resisting qualities which are of considerable value. A tank treated with "Gunlite" was subjected to 10 per cent. sulphuric acid at 200 deg. Fah. for 136 continuous days before the tank broke down through failures at the corners. "Gunlite" would appear to be specially valuable as a protection for concrete girders and columns exposed to the atmosphere or dampness, and it also possesses fire-proofing qualities.

The engineers of the Manitoba Power Co. have announced that by Christmas of this year the first unit of the 170,000 h.p. development project at Grand Falls will be completed, and the power delivered in Winnipeg. This company is a subsidiary of the Winnipeg Electric Co. and the new hydro-electric project will, it is estimated, cost \$7,500,000 to complete, and will do much to provide for the electrical needs of the city of Winnipeg for years to come.

FEDERAL AID, ITS IMPLICATIONS AND RESULTS*

Federal Aid Towards Road Improvements—Co-Operation Between Federal and Provincial Governments— Contracts Versus Day Labor.

By A. W. Campbell,
Commissioner of Highways, Ottawa

WHERE has been established in every province in Canada during recent years, a new department or branch for the administration of advanced legislation on road construction and maintenance. And since 1919, the Canadian Government has been an interested partner in the development of improved facilities of travel on the more important roads, by reason of the Canada Highways Act.

For some years past the tendency has become pronounced on the part of local authorities and also of road users, to look to the several provincial governments for

assistance in providing the country with adequately improved highways. The injustice and inequity of the old burden of having to build for traffic originating outside the limits of local administrative units, have lead to the assumption of responsibility for road improvements in many directions. Hence Federal aid towards the betterment of the roads required to sustain heavier and speedier traffic.

Every producer is beneficially affected by the increased facilities for road transportation

and the Canada Highways Act, 1919, was intended as an instrument of reconstruction, and as such, its value should in part be judged. The chief result of this piece of legislation is that good roads have a very important place in sowing the seeds of national prosperity.

As a matter of fact, Federal aid as authorized by this Act, was the crystallization of many forces, the aim of many conferences and the subject of many a wayside parliament. It was, of course, generally recognized that as the primary avenues of highway travel are improved with government assistance, the lesser travelled roads must receive greater attention and care. Any general impetus to betterment inevitably creates ripples of betterment to the outermost rim of the country's transportation system.

Although the amount of Federal participation in highway construction and improvement is only 40 per cent, of the total necessary and reasonable cost of the selected system of roads receiving aid, there has been a certain amount of co-operation and collaboration with the different road-building authorities of this country, not without their value.

Measures of Co-operation

One of the advantages of having a five-year term during which the Federal appropriation of \$20,000,000, may

*Paper read at the ninth annual Convention of the Canadian Good Roads Association, Victoria, B.C., June 12 to 15, 1922.

be earned, is the possibility of the establishment by each province of continuity of policy no talone in the administrative or executive branch of a department, but also in the highway engineering branch. Any policy of road development cannot well be carried out unless there have been created adequate road funds and an engineering staff properly organized and imbued with the aims of the executive branch. It has been the aim of the Federal department to give moral support to a provincial department that is trying to build for the future, rather than provide shoddy surfaces upon open web foundations and structures requiring constant repair or replacement.

Under the regulations, the provinces are asked to submit a map of a selected system of their main and market roads which they propose to construct with Federal co-operation. In this connection, the importance of seeing that Federal-aid roads shall serve distant as well as adjacent territory, and that they shall link up properly, has not been lost sight of. In this work, direction of which is seen by the provinces concerned to be necessary, co-operative measures are all that is required.

The fact was recognized when the regulations were being framed, that dual inspection of all the operations on Federal aid highway projects was not necessary. Each province is quite as much concerned with the importance in the public interest, of honest work, honestly done as is the Federal Department, and, therefore, a certain emphasis was placed on the importance of seeing that the chief officials having to do with the layout and control of the operations on roads of the magnitude now necessary, have had the training and experience to qualify them to meet the problems arising daily on such work. If the foreman and inspectors have been imbued with the public service idea and the necessity in the public interest of expecting one hundred cents on the dollar in value of workmanship and materials, there would seem to be no good reason why duplicate inspection on behalf of the Dominion Government is necessary. Still, there have been established four inspectorships for Federal-aid highway work, with inspectors whose chief business is to determine the reasonable and necessary cost of the work, and incidentally to co-operate as far as possible with the different provincial district or divisional engineers, by offering constructive rather than critical suggestions. Experience shows that careful investigations into costs of operations involving many variables of quantities and prices are not without their reactions and beneficial effects.

Actual costs are of course determined by travelling auditors of the Federal Department, from examinations of vouchers of outlays made with respect to all projects under agreement. The auditors advise me that they have been welcomed by the different provincial accountants, and in many cases have been asked for their advice on distribution of accounts, etc. That savings have been effected to the provinces as a result of the discovery of accidental over-payments to contractors, for example, need hardly occasion surprise.

One of the items of collaboration is in securing proper records of every Federal aid project. The importance of the recording of investigation data, including photographic records, showing the conditions that have governed recommendations for given types of construction, has not been sufficiently appreciated by some road-building authorities. Records of the condition of the road in bad weather, of the type recommended, of the need for the road, of the dates of completing surveys, of call for tenders, of recommended dates for commencement and completion, they all should form an important chapter in the history of each road. Similarly, the recording of the process of development of these roads should be made the subject of library-record method.

Classification of Roads

When the different provinces were asked, as a preliminary to enter into agreements for Federal aid, to submit a map of a system of main and market roads, in some cases there was delay owing to the necessity of making



A. W. CAMPBELL
Commissioner of Highways, Canada

a selection that would be acceptable to all parts of the province concerned. The question then arose,—"Are not all our roads important?" In order to answer this question it became necessary to conduct some form of investigation of the amount and character of the traffic using all their roads. Traffic studies showed the existence in each province of a number of roads which when connected up by a fairly uniform type of construction, might properly be called main trunk roads; these roads forming the skeleton arterial system then carried the bulk of the traffic. Traffic studies also showed addition a number of trunk roads of lesser importance that might be called secondary trunk roads, and then there was the purely local country road system. Market roads include all three classes, and any local road that does not serve to link farm and market effectively fails in its real purpose. In this connection, it is significant that the aid is extended under the regulations not to main market roads alone but to main and market roads.

One of the results of the classification of the different roads of the province, shows that there has been created in many of the provinces a special primary road system fund to be expended on a selected system of roads. The amount of money left for expenditure on the roads of lesser importance has in many cases increased. Formerly one could not distinguish, in fact, it was generally inexpedient to differentiate in the amount of expenditure and the quality of the work done on the roads in different part of a province. The result of financing, from earmarked funds, the cost of improvements on the primary road system, is that it is possible to build for the future, especially in providing wide grades, adequate drainage structures and outlets, and more permanent types of surfacing.

Preliminary Information

Securing complete information, in advance of the period of undertaking actual construction, by careful studies of the traffic to be accommodated and surveys of the improvements called for, are matters of the utmost importance in controlling costs. Good sound common sense suggests the expediency of securing all possible information well in advance of the proper time for doing the work. It is advisable to have carefully prepared estimates so that they will be a safe guide when awarding contracts, and in the engineering direction during construction, and also the amount of work actually involved in the contract. In too many cases the amount of work done under a given contract has largely exceeded that contemplated when the contract was let. This suggests either careless or insufficient surveying of the proposed work. Revisions of the estimated costs of projects should, with exceptions, with the present trend of prices be downward rather than upwards.

Control of Labor Employed

In reply to a question asked the different provincial departments as to whether the numbers of parties and concerns apparently interested in road construction projects had increased since 1919, every province advised that there had been a greater number of tenders received on an average than formerly. The requirement of the Act that all Federal-aided work shall be done by the tender and contract method, except for special reasons, has undoubtedly been a considerable factor in this regard.

Several provinces have done considerable work, especially grading, the drawing of materials, and lighter surfacing by the days labor method. When this method is used the handling and direction of the labor employed should be done with the same efficiency as if the work were let to contractors. The public interest is wider than the personal inclinations of the labor crew employed on work of highway betterment. Competition or possible competition for the work to be done is always a desirable incentive to the giving of good value for outlays whether as between one contractor and another, or between day labor men.

As a general rule when the provinces have asked for the approval of the Governor-in-Council for day labor work

on any project, the reasons commonly given are,—the work is not large enough to warrant calling for tenders and making the necessary surveys, or the contractors are not interested, or it may be done more cheaply than by contract method. While it may be conceded that it is good business to do certain work by day labor, yet a careful study of the different methods suggests that in the substantial improvement of roads of primary importance, there is real economy in having all the results of traffic studies, surveys, and the definite information required in letting contract work, in the hands of the department before the work is undertaken, even though it be done by day labor. This is the only way in which a reasonable estimates of what the actual cost will be, can be ascertained, or actual comparisons made between costs of different methods of construction. The arguments in favor of day labor work above referred to, may apply to road work ordinarily, but in construction of the magnitude and substantial character now required and being undertaken, much care should be employed in determining which method should be employed. There is, frankly speaking, much suspicion as to the selection of the men, the honesty of the work performed, and the value of the work received in the case of day labor work.

A Word of Warning

It is within the experience of nearly all who have to do with the administration of highway legislation, to realize how greatly public sentiment has changed with respect to the amount of justifiable outlays for road improvement, and it is in connection with this sudden change that I wish to give a word of warning.

The ordinary gravel or macadam road costing from \$1,000 to \$5,000 per mile has suddenly been replaced by cement concrete, asphalt, and the very highest types known today for road improvement. These types of construction cost from \$20,000 to \$40,000 per mile. From this one can grasp the meaning and seriousness of the highway improvement problem as it affects the whole country. Where thousands were referred to a few years ago in regard to road betterment millions are now involved. The result is that provincial departments of highways have now become great spending departments of the government. And this work as yet is still in its first blush in Canada; it is new, and to some extent still novel. Large sums are now required for construction; in a very short time huge sums will also be required for keeping the work completed to the original standard.

Maintenance

Although many articles have been written and much has been said at good roads conventions about the wisdom of proper maintenance work on roads in the name of good business and service to the people, yet it is surprising to find how generally maintenance is neglected, or performed in a haphazard fashion, without organized method. We may learn much from railway practice in this regard. In railway organizations, construction and maintenance-of-way are two separate and distinct departments; while their problems and methods are related they are essentially different. The construction gang works under scientific direction, while the maintenance patrol is more or less an independent unit using discretion and judgment as to when and where patching is required. In both departments there is a responsible chief at the head who receives periodical reports on conditions and progress, and administers a definite appropriation. I would respectfully suggest that the time has now come when this Convention might go on record in favor of the establishment in each provincial department of a separate branch having to do only with maintenance work. I believe that many of the commissions of highways, and highway departments in the United States have a division for maintenance work only, and that such divisions have an annual budget of respectable proportions depending, of course, in many cases upon how well the construction divisions have been permitted to do their work.

The cost of administering maintenance funds and of providing roads uniformly good, depends upon the type, but more particularly upon rigid adherence to type specifications in the original construction. Inferior construction on a road of primary importance is the most costly in the end. With good construction the necessity for second or third year reconstruction is obviated and general patching and replacement eliminated, thus maintenance charges can be controlled.

The federal aid highway agreements require an undertaking to maintain the completed project, with all necessary repairs and renewals, so as to preserve the standard of each particular type of construction, and, pending the submission of the necessary information regarding unimproved sections of a project, to maintain or cause the same to be maintained in an efficient manner.

Development of Motor Transport

Greater attention to maintenance work on highways has been necessary on account of the enormous development of the fast-moving pneumatic-tired traffic in the more settled parts of the country. The heavier vehicles, particularly solid-tired vehicles, unite to disintegrate and then to grind to powder, waterbound macadam and poor gravel roads. Canada has now one motor vehicle to every nineteen persons and, according to service, possibly one to every five. Since 1915 the total registrations have increased five times over.

Increased Expenditure General

Canada is not alone in having to find means for a greatly enlarged activity in road building and upkeep. All the leading countries of Europe, including Great Britain, are annually spending large sums from national revenues in constructing or in improving roads. In the Mother-country a tax on motor spirits furnishes a revenue for this purpose, which is granted in aid by the Ministry of Transport towards worthy projects. In the United States Federal aid to the extent of \$384,000,000 has been voted by Congress since 1916, an average of \$64,000,000 a year. It is reliably estimated that the average annual expenditure for road improvement in that country is nearly \$7 per capita, or about twice the amount being raised in Canada for like purposes.

Result of Increased Activity

Nevertheless, Canada is gaining a reputation for good roads abroad. The records of the Customs Department indicate that the total number of entries of motor tourists from the United States for periods varying from one day to six months is about a half million for last year, and that the total number entering for one month or longer has doubled in the last two years. A remarkable feature of this tourist traffic is the number of cars that have crossed the continent before crossing the border. Of the 29,000 odd cars entering British Columbia, 57 cars from nine different States bordering on the Atlantic and 765 came from States of the mid-interior. Doubtless, a corresponding number of our cousins from the American West motorized to Eastern Canada; some returning to revisit old family scenes of their youths.

With regard to the progress being made in connection with the Canada Highways Act, you will be interested to know that within a brief period of a little short of three years each province has been able to so classify their roads as to single out a plan of trunk provincial highways, such as called for by the Regulations. To date 204 agreements for Federal aid have been authorized for 5,125 miles of road at an estimated cost of \$29,461,515. The total amount of the provincial expenditures audited with respect to this work is \$15,974,591, and the total amount of payments made with respect thereto is \$5,179,275. The total mileage of completed Federal aid work at the end of the year was 1,400 miles, and the mileage under construction was 2,397 miles.

HIGHWAY AND TRANSPORTATION PROBLEMS*

Review of Good Roads Situation in Prairie Provinces—
Construction, Drainage and Maintenance—Road
Building a Co-Operative Enterprise.

By Hon. S. J. Latta,
Minister of Education, Saskatchewan.

BECAUSE of the lack of good roads and improper land settlement, the cost of the transportation of produce to railway points is often far in excess of the cost of railway transportation. It is asserted also by those who have given the matter consideration that the railway traffic at country points falls off in many cases to as much as 50 per cent. during seasons when the roads are, as a consequence, unfit for travel. The absence of proper road communication is probably the most serious handicap, both to those who have money invested in railway industry and to those who live upon the land. In fact, no railway system can serve the people for whom it is constructed to the maximum of efficiency unless co-related with it there is developed and maintained a system of good roads.

Over in our great Province, Saskatchewan, there are 210,000 miles of road allowances, a strip sufficiently long to encircle the globe eight times and have a few miles left over at that. On the principle that 80 per cent. of the traffic passes over approximately 20 per cent. of the road mileage, there are in Saskatchewan's system over 30,000 miles of main market roads, here again sufficient to go round the globe once and back again to the Old Land.

The population of a little less than 800,000 is spread over an immense area. In 1911 the density of population was 1.95 people to a square mile.

The land area of the three Prairie Provinces is estimated at 371,000,000 acres. Over 121,000,000 acres have been disposed of, including 60,000,000 for homesteads and 38,000,000 of Hudson's Bay Company land.

About 17 per cent. of the land disposed of is under cultivation. In these Provinces within 20 miles of a railway there are over 15,000,000 acres of excellent vacant land, over 12,000,000 acres within 15 miles, nearly 9,000,000 acres within 10 miles and about 4,500,000 acres of fertile vacant land within 5 miles of railway facilities.

Great Individual Cost

Look at the problem then from another angle. Only a bit of calculation is necessary to disclose the fact that upon a family of four people, less than the average, is shouldered the enormous responsibility of building and maintaining one mile of roadway, and upon five average families the construction and maintenance of a mile of main market highway.

The economic use of land in a general way seems to have been regarded as least incidental rather than essential. This system tended to the marking out of too many miles of road because there are more miles of road than, on the most liberal estimate, the taxpayer is able to construct properly.

The rural percentage of population in Saskatchewan fell from 80.7 in 1901 to 73.3 in 1911, and further to 73 in 1914. In Manitoba it dropped during the same period from 72.4 to 44, in Alberta from 71.8 to 60, and in British Columbia from 49.5 to 44.6. In Ontario there was also a decrease of 4 per cent. These figures relative to the rural population are quoted, not with any desire to depreciate the value of the urban, but rather to provide material for consideration in the development of an all-round and well-balanced population.

The development and location of our railway systems have had a very material effect upon the location of our population and the development of our natural resources. No particular blame is attached to any one be-

*Presidential address at ninth annual Convention of the Canadian Good Roads Association, Victoria, June 12-15, 1922.

cause of the failure of this work to accomplish the maximum of good. Had the present generation been entrusted with the task of those of earlier days without the experience of the past, many of the mistakes of earlier days better, but because those of the present have the experience of the past, many of the mistakes of earlier days must be avoided. In future, railway systems, if the maximum of good is to result, must be scientifically planned, duplication must be avoided, and location must be attended, so that localities fit for development may be populated. In short, the wise railway policy of the future, both in the interest of the settler and the railway capital invested, will be such as to make the location of lines conform to a previously considered and scientific plan of land settlement and rural and urban development.

Factors Governing Types

In dealing with the type of road to build, the same principle has been expressed in many ways, but could be summed up by stating that the type of road to build on any part of a system is that type which will carry the traffic which will go over the road at the least possible expense, direct or indirect. In other words, there must always be recognized the close relation existing between the type of road chosen and the quality and quantity of the traffic going over it. It is bad business to put \$20,000 a mile into a road over which the traffic is light and equally bad business to be content with a one thousand-dollar road where the traffic is very heavy.

What has been in a very general way is applicable also to the choice of type of culverts and bridges. There are instances of a very expensive and high type bridge being the least economic type to choose for a certain location, and, on the other hand, where it may be false economy to build a low type bridge at small cost. All kinds of bridges and culverts may be as scientifically correct as all kinds of roads.

Road Construction

During the past number of years it has been my lot to consider the highways problem in its wider aspect. Details of construction have been left to the ingenuity and efficiency of men trained in engineering and practical road building. My observations, however, have caused me to arrive at certain general conclusions regarding the construction of roads.

Drainage to me is the great thing. Without proper drainage a road otherwise well constructed cannot serve its purpose to the maximum. If it were practicable to smooth down a stretch of roadway, then build a tent over it, so that it might be always dry, 90 per cent. of traffic trouble would disappear. Drainage in the matter of construction is of paramount importance, and the greatest ingenuity of the best engineering skill ought to be directed to this end. Whether the type be of a low grade earth road or of the highest type of hard surface, road drainage is equally important. The expense saved in the neglect of proper drainage is money wasted in the matter of construction. Just as much engineering skill of its kind is demanded in the proper construction of a low type road as in that of a high type.

Herein is laid the foundation for the road of higher type at once the population and traffic demand it. If the foundation be not well laid, then the capital expended has been expended in vain. Sometimes it may be impossible to do so, but in every single case where at all possible, every single dollar spent, ought to be so spent as to be useful as soon as the surfacing for a higher type is demanded.

Maintenance

One of the greatest problems of the present is that of proper road maintenance. It is simply appalling to consider the enormous sum of money in the aggregate already invested in Canada's road plant, and at the same time to view the neglect in the aggregate of effort to preserve the capital thus invested. Here, again, the matter is of equal importance whether the road is of high or low type.

I do not believe, as some have stated, that the money spent in the maintenance of the much maligned earth road is money wasted. The money not spent in the maintenance of the low-type earth grade is the money wasted. Just as it is economically on some parts of a system to choose an earth grade to suit traffic conditions, so it is true economy to keep the earth grade in good repair.

Organization for road maintenance all over Canada is only in the pioneer stage, and an exchange of experience along these lines ought to be profitable indeed. It is a subject, on the whole, fit and proper to engage the attention of all organized bodies having to do with higher construction all over Canada.

Financing Roads

Next to education, the financing of highway construction is probably the largest problem with which the Canadian taxpayer has to deal. The enormous expense, direct and indirect, of transportation, railway and road, calls for the consideration of the best brains in finance and construction that Canada is able to produce.

All over the continent of America, in every State of the Union and in every Province of Canada, Governments, Federal, Provincial and municipal, are appropriating millions for the construction of roads, a fact that accentuates more than ever the necessity of attention to this element of the problem. Great care is not wasted, as every dollar is needed and every dollar ought must be expended so that the millions are put to the best possible use.

Municipal Responsibility

Generally speaking, the financing of roads is a responsibility, in the main, shouldered upon the municipality. The function of the Provincial Administration is largely directive, educative and assistive. In some provinces the Government has undertaken the responsibility of constructing and maintaining certain provincial highways. The difference in policy, however, is largely resultant upon a difference of conditions or a difference of viewpoint. However the responsibility may be distributed, the burden of bearing the load in the end belongs to the taxpayer.

In the matter of Dominion aid or Provincial aid, it seems to me that certain principles ought to govern the distribution of funds. Road building is a great co-operative enterprise. The taxpayers of any given community, a community, if you will, co-operate with each other in the interest of all. Two elements enter into the method of the contribution of funds to carry on the co-operative enterprise, first, ability to contribute, and second, the benefit derived from the utility provided. If this principle be sound, then Provincial aid to the communities within the Province ought to be given on the same basis. It is quite evident that a basis of population may not fulfill all the requirements of the purposes of co-operation. In like manner it may easily be shown that the distribution of Federal aid by the Dominion Government among the Provinces on the basis of population may be unjust and inequitable.

A sewer over six miles long and running through the most populated sections of the South Shore, and which will cost over \$370,000, and intended to serve Longueuil, St. Lambert, Montreal South and Greenfield Park, is now nearing completion. The sewer is constructed of large pipes, each length of which weighs 20 tons. It commences in Greenfield Park, back from the river, runs to St. Lambert, follows the river-line through Montreal South and Longueuil where an outlet below the Longueuil church site brings it into the river-bed, along which its outfall is laid for 1,360 ft.

The new high level bridges at Hamilton, which will carry the Toronto-Hamilton Highway, will be opened for traffic on July 1. The bridges will not only obviate the necessity of taking the Valley Inn hills, but also will carry the traffic of the Guelph road and the Dundas road out of Hamilton on the level.

DRAINAGE METHODS FOR PRAIRIE ROADS*

Surface and Sub-Drainage—Roads with High Crown not Suitable for Roads in Saskatchewan—Construction of Side Ditches and Culverts—Drifting Soil.

By H. R. MacKenzie,
Chief Field Engineer, Saskatchewan.

THERE are two distinct kinds of road drainage, surface drainage and sub-drainage. Surface drainage is the principal factor in the construction of roads in the prairie provinces. Transverse surface drainage is obtained by crowning the road; the height of crown varying somewhat with the different classes of soil. On roads being constructed in Saskatchewan under the provisions of the Canada Highways Act, the standard height of crown is 6 in. for 20 ft. road surface, or a slope of slightly more than 1-2 in. to the foot. From the proceedings of previous conventions held by good roads associations, we find that a good many engineers recommend a crown slope of 1 in. to the foot, and on heavy clay soil a slope of even 1 1-2 in. to the foot has been recommended, but the writer is of the opinion that those who recommend a high crown on a heavy clay road, have had no opportunity of becoming intimately acquainted with the heavy gumbo soil found on the prairies. After a shower of rain lasting 20 or 30 minutes, it is practically impossible for anyone to drive a car on a road in the gumbo districts with a crown slope of 1 in. to the foot or over.

High Crowned Roads

Owing to the very slippery nature of gumbo when wet, a highly crowned road in this class of soil is impassable in wet weather, but how about its relative serviceability in dry weather? We have long dry periods in July, August and September on the Western plains. The heavy soil bakes hard, cracks and becomes broken into granular particles by traffic, and is thrown out of the wheel tracks by rapidly moving motor cars, with the result that deep ruts develop and the surface is so hard that it is impossible to repair the damage satisfactorily, until the surface is softened by rain. On an excessively crowned road, the traffic is confined to the exact centre of the road surface and consequently the development of deep ruts in dry periods is accentuated. If the road had a reasonably slight crown, traffic would be distributed over the road surface and the maintenance problem would be reduced. Another feature, is the safety of the travelling public. On a high crowned road, cars in passing are always liable to skid into the ditch and upset, even while travelling at moderate speed, whereas on a 20 ft. road with 6 in. crown, cars can pass in safety at any reasonable speed. Still another feature in connection with high crowned roads, is the severe wear and tear on tires. When ruts develop in the centre of road, due to the concentration of traffic at this point, a new track is developed on either side of centre line, forming two definite lines of traffic, and on both of these the rear wheels of motor cars are constantly skidding down the slope, making the driving of a car difficult, dangerous and expensive. A high crown has the serious disadvantage outlined above, and furthermore, is not required for adequate surface drainage. Water will be discharged just as well from a slope of 1-2 in. to the foot as from a slope of 1 in. to the foot, providing the road surface is kept free from ruts by proper maintenance, and grass and weeds are not allowed to grow on the shoulders of the road. When, after a rain, the water has all been carried away and the surface of the road remains smooth with no signs of erosion, the crown slope may be taken as being satisfactory. In the case of excessive slope of crown, small rivulets will appear caused by the too rapid discharge of water.

On steep grades the crown of a road should be increased slightly so as to minimize the danger of water run-

ning down the road surface in a longitudinal direction, an application of sand or gravel being required to prevent skidding in the case of heavy clay soils.

Transverse Drainage

The transverse drainage of side hill roads in Saskatchewan is very often accomplished by having the entire road surface inclined towards the ditch at a slope of $\frac{1}{2}$ to $\frac{3}{4}$ in. per foot of width. This method results in more water being on the road for a longer period than in the case of an embankment where the slope is from the centre towards the side, and also causes a greater volume of water in the ditch with relatively greater erosion resulting. This type of cross-section is used on the provincial highways of Saskatchewan only on sharp curves and heavy side hill cuts where the slope of road-bed towards the hill adds somewhat to the safety of the route. On comparatively straight side hill grades where the transverse slope of hill does not exceed 20 per cent, part of the surface water can be advantageously discharged over the embankment by the crowning of the road surface.

The second stage of surface drainage is the conveying of water discharged from road surface to a natural water course, or to a large slough or lake where the additional volume of water will not cause damage to public or private improvements. The transverse drainage of road surface can be perfectly obtained, but longitudinal drainage is often a very difficult problem in connection with highway construction. To provide ideal surface drainage we require that the side ditches, culverts, bridges and outlets constitute a system capable of draining completely the water from rain and spring thaws as quickly as possible but without erosion. The small number of natural drainage channels, and the uniformity of elevation on the prairie sections of our mid-western province makes longitudinal drainage unusually difficult; also, the absence of trees and shrubs on prairie sections increases the rate at which surface water is discharged, and also increases the amount of the discharge, as compared with treed areas. These conditions, combined with the large catchment basins of our natural water courses, cause extremely severe flood conditions, which make necessary special provision for adequate water way.

Side Ditches

We shall now consider the construction of side ditches and offtakes. Judging from an examination of a large mileage of road, constructed under the supervision of local municipal authorities in the Province of Saskatchewan, it is evident that in a great many cases it was considered that when the road surface was given a very high crown, adequate provision for drainage had been made. The side ditches are often constructed purely for the purpose of securing material for the crown, and the result is elongated ponds, not drainage ditches. This is a very serious mistake, and the emphasis is being put in the wrong place, for the drainage of the right-of-way is of far greater importance than the transverse drainage of road surface. Such sections of road are invariably rutted, unless the embankment is 3 or 4 ft. above water level, whereas under similar conditions of soil and rainfall, the balance of the road is in first class condition.

It is expensive and usually unnecessary to provide long sections of side ditches at a uniform gradient. Most of Saskatchewan is sufficiently rolling that continuous drainage can be provided from each summit to the nearest culvert without any serious difficulty. The gradient on these ditches is not necessarily uniform. On our provincial highways we endeavor to provide for the removal of all water from the side ditches and borrow-plots. We also endeavor to drain, or at least lower, the water level in sloughs which are on the right of way. If the depth of water in the slough exceeds 2 ft. and extends for a considerable distance, and cannot readily be drained, we usually divert the road so as to avoid the slough, having in mind the high maintenance charges on a road constructed through a body of water.

*Paper read at the ninth annual Convention, Canadian Good Roads Association, Victoria, June 12-15, 1922.

The side ditches on roads improved by the Department of Highways are so designed that they can be constructed and maintained by standard road building and road maintenance machinery. The standard depth of side ditches is 18 in. on our provincial highways. In the case of turnpiked sections of road the inside slope of ditch is 4 to 1 and the outside slope 1 1/2 to 1. In the case of a roadway in excavation, the inside slope of the ditch is increased to 3-1 in order to reduce the volume of excavation by reducing the out to out width of roadway, maintaining the same depth of ditch and crown width.

In the case of a roadway constructed around the base of a hill, it often occurs that the roadway could be built at the same elevation for a considerable distance, but as there must be a slope to the side ditch, we construct the road to a slight gradient so that the ditches may be of uniform depth. If a level stretch of roadway were constructed the ditches would be shallow at the centre of the level stretch and too deep at the outlet. In the case of all excavations we provide for a slight gradient to roadway so as to facilitate drainage.

Offtake ditches are provided when there is not a sufficiently well defined water course to carry away the water discharged from any culvert. When the distance from summit to culvert is only 2 or 3 stations we find that the surface water can be satisfactorily disposed of by digging a ditch from culvert outlet to the edge of the right-of-way and discharging the water into the adjoining field—well tilled soil will absorb this quantity of water without damage and if the land is not cultivated, no objection is usually made to this method by the owner of the property. At every point where water is carried through a culvert under the roadway, we endeavor, if possible, to discharge this water from the right-of-way directly opposite the culvert.

Drifting Soil

We have a difficulty in connection with surface drainage which is unknown in other portions of Canada. That is, the almost annual obliteration of road ditches by drifting soil in prairie areas where the soil is heavy. We have severe wind storms during March and April which cause the clay soils pulverized by intensive cultivation, to drift like snow. In a great many cases, turnpiked roads are not only obliterated, but are rendered very difficult to rebuild, owing to the granular nature of the drifted soil which, by the way, is often mistaken for sand. This granular material is very difficult to handle with a blade grader, as it runs around or over the blade, and the clearing of the ditches is a real problem. When you have succeeded in removing the drifted material from the ditches to the crown of the road, you have also succeeded in rendering the road impassable, as this material cannot be consolidated except when wet.

Two years ago, a ditch approximately 1,000 ft. long and 2 to 3 ft. deep, was constructed to drain a slough which was situated on the right-of-way of one of our trunk roads. This ditch was completely filled by drifting soil the following Spring, but on account of the granular nature of the material, the ditch continued to be effective for one season, but ditches required to carry running water are immediately rendered useless when filled with this material. To maintain many of our roads we will have to build protection fences, similar to snow fences, to prevent the drifting soil from filling the ditches, unless the Agriculturists devise a system of crop rotation which will provide sufficient fibre in the soil to prevent this drifting action.

Culverts

Culverts form a part of a surface drainage system, and the following are the types of culverts installed on roads being improved by the Provincial Department of Highways:

- (1) Pipe Culverts, (a) Corrugated iron; (b) Concrete.
- (2) Box Culverts, (a) Concrete, (b) Timber

(3) Arch Culverts of Concrete.

On our trunk roads we do not use timber culverts, except in special circumstances. We believe that culverts of a permanent type should be used exclusively on main roads and we are able to adhere to this policy excepting where we find it necessary to provide large openings to carry off the spring floods.

Our river valleys are deep and vary in width from 1-4 mile to 4 miles. Very often the entire valley is flooded in the Spring, and we have to construct embankments of from 3 to 5 ft. in height across the flats tributary to the river. To protect these embankments against spring floods we have to provide culverts having 16 to 20 ft. clear spans at the several points where channels develop when the river is in flood. The cost of constructing 3 or 4 permanent culverts of these dimensions, possible in one mile of road, is almost prohibitive, in view of the amount of funds available, consequently under these circumstances we have to resort to pile bent culverts.

In connection with the use of pipe culverts, we find when these culverts are placed sufficiently low to remove all water from the side ditches, they are quite useless during the spring run off, unless the snow and ice has been removed from the culverts by a maintenance patrol. Alternative thawing and freezing during the month of March often fills the culverts with ice, which is very difficult to remove, and consequently we find it necessary to use box culverts with a considerable vertical opening at points where there are natural water courses. At smaller runways we often place a culvert at natural surface elevation to take care of spring run-off. When installing a pipe culvert as an even in an embankment constructed across a slough, we place the culvert on solid ground near the end of the embankment, at an elevation equal to the normal water level in the slough. The average cost of culverts varying from 12 in. to 36 in., diameter per mile of road is approximately \$400.

Sub-Drainage

As already mentioned we are unable to build hard-surfaced road in the rural parts of our province, consequently we do not provide under drainage on our roads except in so far as side ditches remove water from the roadbed if they have a proper gradient and an outlet, or provide a source of water to be carried through the sub-grade to the road surface by capillary action if water remains in the side ditches for any length of time.

We occasionally find it necessary to provide under drainage in a cut where the earth formation is such that water continues to seep out of the hill to the roadway, the method adopted being a rock filled ditch, but tile underdrainage on earth roads in our province, where the average cost per mile of roadway does not exceed \$2,000 is not to be considered. Even if the necessary funds were available, the writer questions the serviceability of a tile drain at a depth of 2 or 3 ft. in a heavy gumbo soil which will retain water in undrained side ditches for a period of 2 to 3 weeks until it disappears by the process of evaporation.

We adopt the principle of under-drainage by endeavoring as far as possible to keep our roads on the natural surface, and avoiding deep cuts. The surface soil is more porous and has a great many passages made by worms and insects, decaying roots, etc., consequently a road on surface soil has considerable sub-drainage already provided, also evaporation is much more effective on the surface than in a cut.

Our experience in connection with sub-drainage is so limited that the writer will not attempt to discuss the matter further, but we are fully aware of the fact that the fundamental basis of all road maintenance is drainage, and we are endeavoring in the face of unusual difficulties to provide proper and adequate ditches and culverts on our provincial highways system, so that with careful attention our earth roads, the only roads we can at present afford to build, shall render to the taxpayers of our province the maximum service of which they are capable.

IMPROVING EARTH, CLAY AND SAND ROADS*

Physical and Soil Conditions in Alberta—Methods of Grading Prairie Roads and Roads in Timbered Districts—Cost of Grading.

By J. D. Robertson,

Deputy Minister of Public Works, Alberta.

LOCAL conditions make it rather difficult to apply a uniform method of road construction to the Province of Alberta as a whole, running as it does into the foot hills and mountains on the west, timbered country with occasional swamps and muskegs to the north, and rolling and level prairie to the south and east. Soil conditions also vary a great deal. Generally speaking the soil is excellent for agricultural purposes, but the better it is in this respect the less desirable it is as a road building material.

In view of these facts you will no doubt appreciate our difficulty in preparing specifications for construction of roads applicable to the entire province. If, on the other hand, it was sufficiently developed to warrant hard surfaced construction we could ship the required material by rail if necessary and thus adopt uniform methods of construction.

For this reason we must follow the method of construction, which in our opinion is best adopted to local conditions and controlled by the amount of money available for the work. In stating how to improve sand, clay and earth roads, as I cannot outline in detail any particular method applicable to Alberta as a whole, I will choose our two extreme conditions, that is the method we adopt in open level prairie, and on the other hand the method followed in fairly heavy timbered country to the north end of the province.

Road Improvements Over Prairie

First let me deal with our method of road construction in level prairie country; all material for crown being obtained from the side ditches. We usually construct our more important main highways a width of 28 ft. between the outside of ditches. Others that are not required to carry as much traffic are very often constructed 26 ft. between ditches, and the local roads carrying still less traffic have a width of 24 ft. This provides a travelling surface of 20 ft., 18 ft. and 16 ft. respectively. Where any of the above mentioned roads carry excessively heavy traffic, as leading into a city or large business centre, the width may be increased by not more than 2 ft.

In constructing a main highway 28 ft. between outside of ditches two lines of pickets are set 28 ft. apart, equal distance from centre line of road allowance. When the tractor which provides the power required, is used for hauling heavy 12 ft. blade grader, plowing is not necessary. The first round trip is made down one line of pickets and back the other which constitutes one round or two running-miles for each mile road graded. In the first round the outside end of the grader blade is dropped well down and forward, which cuts very much as if it were a plow. In the second round the position of the blade is changed slightly so that on this trip the material is pushed to within one foot of the centre of the road. Generally speaking we now have all the sod that is to be moved in the centre of the road overlying the centre 18 ft. of 20 ft. of original prairie sod which has not been disturbed. The third round is a second plowing with the blade grader in the side ditches, this material being fairly free from sod. The fourth round again pushes this material to within about one foot of the centre of the road, covering the sod. The fifth round pushes the material to the centre of the road, but instead of the road being suitably crowned it usually comes to a peak in the centre, more in the shape of a roof. A further trip one way is

therefore necessary, which is carried out by setting the grader blade straight across the road and proceeding to the end of the new grade. Camp is usually moved at this time by hauling the cook car and other equipment behind the grader. The grader removing the ridge from the centre of the road and giving the road the necessary crown, and at the same time makes wheel marks in the centre of the new grade, which acts as a guide to traffic following. This last trip constitutes 1-2 a round making 5 1-2 miles all told, or 11 running-miles for each mile of road graded.

I might add here that we consider 5 1-2 miles the maximum required and very often a 1-2 is sufficient for a road 28 ft. between ditches, and is invariably sufficient for a road 26 ft. or less between ditches. Work of this nature should usually be done in the spring or early summer when there is sufficient moisture in the ground so that the grade will consolidate for it is absolutely useless if carried out after midsummer during a dry year, as there is nothing but a pile of dust through which it is impossible to travel.

The Government own all graders used for work of this nature, but do not own the tractors. We believe it is more economical to run the tractors on a mileage basis, paying \$9 to \$10 per running-mile for the use of the tractor, including cost of operation and repairs. The department usually pay the man who operates the grader, he being held responsible for bringing the grade to the proper cross section and keeping a record of the number of miles made by the tractor. This work would, generally speaking, average from \$90 to \$100 per mile and for this amount we obtain an 18 ft. to 20 ft. surface for traffic with a side ditch 15 in. to 18 in. deep.

Further work may be necessary to provide a road surface suitable for traffic, depending entirely on the nature of the soil. It may be necessary to use a disc or harrow to cut sod or break down lumps, and use a road drag to level the surface. In other sections of the country it may also be necessary to remove rocks from the grade. When such is the case they should be cast well outside the ditches.

With this method of road construction the grade line of the side ditches conforms to the contour of the ground surface and does not likely provide for carrying surface water to drainage outlets, but is liable to form pools in every depression. It is therefore necessary to bring the side ditches to a grade line that will prevent the water lying along the grade. It is also important that all necessary culverts be installed. They should be put in immediately after the grading is completed so that the fill over the culvert, will properly consolidate with the road bed.

The cost of such road including culverts and ditches over fairly level prairie would run approximately \$300 per mile, depending of course on the number of culverts required and the amount of drainage necessary. In passing I wish to draw your attention to this fact that the travelling surface provided is only of material taken from the side ditches, such as it is.

Through Timbered Country

I will now deal with our method of road construction in the timbered portion of the province, assuming that all material for grade is obtained from the side ditches and that the distance between outside of ditches is 28 ft. We first must locate our property line and usually stake out the central 33 ft. of the road, which is cleared and grubbed. In clearing various methods are followed, but I believe the one giving the most satisfactory results is that of cutting the trees off about 3 or 4 ft. up from the ground. This gives an opportunity with a block or team, depending on the size of the trees with hitch near the top of the cut off, to pull out the stump. If they are any size it is usually advisable to first shoot a stick of stumping powder under the stump which loosens the stump, but the principal benefit derived is that it jars the earth loose from the roots so that when the stump is pulled out, it comes out clean and without bringing a large quantity

*Paper read at ninth annual Convention of the Canadian Good Roads Association, Victoria, June 12-15, 1922.

of earth with it. All stumps, roots and other fibrous matter are cleared from the central 33 ft. of the road, which is absolutely necessary to permit the grader to do its work. The cost of clearing and grubbing is generally figured on an average basis, varying from \$10 to \$50 per acre, depending entirely on the class of timber to be cleared. In heavy spruce it might cost even more than \$50. However the timber is not generally heavy in Northern Alberta, being mostly light poplar. A fair average I believe for this kind of material would be \$25 per acre for clearing and grubbing the central 33 ft., which means an expenditure of \$100 per mile with an extra \$15 an acre for clearing only, the balance of the road allowance, being an expenditure of \$160 per mile for clearing the entire width of road allowance and grubbing the central 33 ft. This is only an average, as we have had instances where this work would cost up to \$1,000 per mile. The brush, roots, etc., are piled and burned. We next grade the road with an 8 ft. horse grader, hauled by at least 4 teams. It is usually necessary to first plow two or three furrows on each side of the road. The material is then pushed in with the blade grader after the same manner as is done in prairie grading, except that the same progress cannot be made, more trips are usually necessary owing to the small roots encountered. It is invariably necessary to disc the road well after grading and again trim it up with a grader to obtain the necessary crown, which would likely cost \$125 per mile. Further work to improve such a road and open it for traffic would depend entirely on the nature of the country.

The clearing, grubbing and grading I have referred to, will only answer where the ground is high and dry and naturally well drained. Usually however besides drainage and installing culverts there is considerable other work to do such as laying corduroy or brush and making cuts or fills.

Brush and Corduroy Roads

In connection with corduroying, the material is cut 16 ft. in length and laid side by side across centre of road. Where the material can be obtained within 1-2 a mile the cost is about \$2.50 per rod, which is at the rate of \$800 per mile. This is only used in passing over muskeg or low land that will not support an earth fill. A willow brush mat of the same width, laid 12 to 15 in. deep can be done for about the same price. Willow brush is laid with tops overlapping in the centre of road. The brush tops from one side of the road are carried throughout as a lower layer and the tops from the other side forming an upper layer so that when the brush is being covered the teams can then swing with brush tops. This is a very important feature in laying brush and the proper laying of the brush greatly reduces the cost of filling. Brush and corduroy is usually only necessary for a short stretch and therefore only represents a small percentage of the total mileage being worked. I might state that generally in fairly heavy timbered country it would cost about \$150 per mile for brushing or corduroying. We then have installing culverts and making fills, and most important of all ditching, as drainage is the all important feature especially constructing roads in a timbered country. The main feature we always keep before our men is to get the water off. The cost of improvements of this nature would run from \$600 to \$1,000 per mile in timbered country such as exists in Northern Alberta, which invariably includes stretches of low land required to be brushed and corduroyed. We, therefore, might easily strike our average \$800 per mile.

I first dealt with road improvement for prairie country and arrived at an estimated cost of \$300 per mile. Through timbered country \$800 per mile. The balance of the province will vary between these two amounts depending on the nature of the country through which the road passes. In either case what have we got? Principally a road constructed of material taken from the side ditches, such as it is, which presents a travelling surface that if properly dragged throughout the season is a very

fair road to travel upon during dry weather. But during the wet weather there will be many sections of road that would not carry traffic without injury to the road and danger to those attempting to travel. When the soil obtained from the side ditches is of sand, fine gravel or a sand clay mixture a very fair travelling surface is provided even during wet weather. On the other hand where the soil is exceptionally light it is quite satisfactory in wet weather, but is not at all suitable in dry weather. Again where gumbo or heavy black loam is encountered one usually endangers their life by trying to drive a motor vehicle over it after a rain, and after a period of wet weather the traffic will ruin for the time being, this portion of the road.

Mileage Graded

We have in Alberta approximately 15,800 miles of continuous graded roads and 28,500 miles approximately of road where the necessary culverts have been installed, fills made where necessary, but not continuously graded throughout as the drier sections carry traffic without further improvement. We have approximately 12,500 miles of regular road allowance which can be travelled and upon which no improvements have been made, with an additional 3,000 miles of angling trail temporarily used in lieu of regular roads not yet opened. We therefore have approximately 60,000 miles of graded road or trail in use at the present time with another 80,000 miles of regular road allowance in the fairly well settled portions of the province, which have not yet been opened for traffic, which serves approximately 100,000 resident ratepayers outside of the cities, towns, villages or hamlets. Of the 15,000 miles of continuous graded roads, a very small percentage, possibly not over 300 miles all told, have been surfaced with material other than that taken from the side ditches or where fills have been made the material borrowed from the adjoining knolls.

In Alberta gravel is scarce, while there are isolated deposits of gravel they are so scattered that the cost of haulage practically prohibits their use at our present state of development. I feel, however, that our solution is the mixture of sand and clay, as in the sections of our roads where we encountered a sand clay mixture in the proper proportion, a fairly good all weather road is provided.

In conclusion I wish to state that we have about 3,000 miles of main highway, which carries fairly heavy motor traffic from early spring until late autumn, together with an equal mileage of main market roads, which are not standing up under the traffic which they must accommodate. It is apparent that for these roads at least we must provide a more suitable wearing surface than that obtained from use of material from side ditches.

An old prairie trail is all that could be desired for very light traffic, but as soon as traffic increases beyond its carrying capacity it is absolutely useless. The same applies to our roads built from the side ditches regardless of quality of material used. Our problem in Alberta at the present time is to devise ways and means of further improving the wearing surface of our earth roads with the material available for the purpose, such as gravel or sand clay, always keeping before us the vast mileage to be improved and the extent to which Alberta is developed at the present time.

Announcement is made by Mussen, Ltd., that they are now agents for the entire Dominion for the Western Wheeled Scraper Company's line of earth-handling and grading machinery, and that stock of a large part of this line is now being carried in Toronto as well as in Montreal. This is the first time, state Mussen, Ltd., that this line has been available in Ontario for immediate delivery to grading and highway contractors and municipalities.

The cost of the Welland Ship Canal when completed is estimated at \$55,000,000. The original estimate of the cost of the canal was \$50,000,000. Up to date the expenditure has been \$30,000,000.

ECONOMICAL METHODS OF HANDLING MATERIALS*

More General Use of Machinery in Road Construction—
Reduces Handling Costs and Expedites Work—Con-
tractor Should not Have too Much Equipment.

By Lt.-Col. H. L. Bowlby,

President, American Road Builders Association.

WHEN it is understood that the cost of handling, on the job, the materials that enter into the hard surfaced road runs from ten to fifteen per cent. of the total cost of the pavement, the great importance of doing this work economically is obvious.

Road building today is in a machine-made era. The successful contractor is the one who provides himself with equipment suited for economically handling his materials, taking into consideration, of course, local conditions and the available supplies of such materials.

The equipment required depends, first, upon the character of the improvement, whether it is an earth road, gravel road, water-bound macadam, bituminous macadam, asphaltic concrete, bitulithic plain or reinforced Portland cement concrete or brick road. Given the character of road to be built, the selection of a proper plant depends upon the size of the job and local conditions.

The common materials to be moved and handled are: earth, sand, gravel, crushed stone, cement, water, hydrated lime, steel reinforcement, asphalt, brick and stone screenings.

Use Machinery Now

The principal new departure in the moving of earth excavation has been the recent development of the use of caterpillar tractors with very large road scrapers and the use of mechanical subgrade planes for trimming up the sub-grade to the established grade line immediately ahead of the laying of the pavement.

Sand, gravel, broken stone and stone screenings are handled today by the large contractors with machinery. Mechanical loaders are used for filling motor trucks or railroad cars. Locomotive cranes, mounted on caterpillar treads, are much used for handling these materials by means of clamshell buckets. In some instances locomotive cranes, mounted on standard or narrow gauge railroad trucks, are used, especially in the large central material yards. When the sand, gravel, broken stone and cement are transported from a central material yard to the mixing gang on the road, small cranes are used to transfer the large batch boxes from the motor trucks or industrial railway to the concrete mixers.

Practice in those states that are doing the greatest amount of concrete road building, seems to be standardizing on the use of narrow gauge railway equipment for hauling the mineral aggregates to the mixers on the road. The trains consist of gasoline or steam locomotives pulling flat cars which carry a number of batch boxes, each containing a full batch for the mixer. The track is laid along the shoulder of the road. Turnouts and switches are provided as needed and moved at night so as not to interfere with the next day's work. Some contractors are hauling the batch boxes of aggregates with motor trucks from the material yard to the mixer. It is constantly becoming more popular, however, to permit the mineral aggregates to be piled on the subgrade and have the mixing gang work through them.

Water is supplied to the mixer and for curing the concrete pavement by means of a pipe line laid alongside of the road. This practice is almost universal.

In some states the wet mixed concrete is being hauled from a central mixing plant to the road in much the same manner that the "hot stuff" is hauled out from a central asphalt mixing plant to an asphalt pavement un-

der construction. The hauling of this wet mixture is done mostly with dump trucks of various kinds.

The mineral aggregates in a central material yard are handled nearly altogether by machinery. A locomotive crane with clamshell bucket usually unloads the sand, gravel or stone from the cars or scows to large storage piles. From these piles the materials are transferred to appropriately arranged bunkers by means of cranes and clamshell buckets. The batch boxes, whether to be moved to the job by motor-trucks or by industrial railway, are filled with the proper proportions of fine and coarse aggregates from the bunkers. Many ingenious measuring devices are used at the bunker gates for proportioning the sand, gravel or stone as the batch boxes are filled.

In the construction of bituminous roads, the mineral aggregates are handled in much the same manner as above described for concrete roads. The chief difference is that the bituminous-concrete or "hot stuff" is always mixed at a central mixing plant and then hauled to the road, dumped, immediately spread and rolled.

The asphalt is usually transported to the central mixing plant in barrels or metal drums, although in some instances it is brought to the plant in tank cars or tank motor trucks. The handling of the bituminous material from the barrels or tanks to the mixer is universally accomplished by means of large melting kettles and small pumps which lift the hot asphalt to the measuring bucket immediately over the mixer.

When motor trucks are used to transport the mineral aggregates to the pavement laying gang, it is usually necessary to provide mechanical means for turning the trucks around on a comparatively narrow roadway. There are on the market a number of turn-tables which accomplish this purpose satisfactorily.

There is a great tendency today among contractors to over-equip, to purchase too much plant for the job. The wise contractor has available just enough machinery and equipment. When he is over supplied with equipment he loses money in several ways. Among these are excessive overhead and depreciation, and a general slowing up of the work due to too many "tools" on the job. The wise contractor also hires the best superintendent of construction available, knowing that a hundred dollars extra per month on this expense means many thousands of dollars saved on handling costs.

The greater part of the hauling of road materials since the end of the World War has been done in the United States with motor trucks. This practice has been adopted in all of the states. One of the principal reasons for suddenly changing from horses and wagons to motor-propelled vehicles has been the free distribution by the Government to the State Highway Departments of surplus motor trucks. During the past three years there have been thus distributed approximately 30,000 motor trucks of various capacities. The further distribution of several thousand caterpillar tractors of 5 and 10-ton capacity, has given an impetus to the more economical handling of earth excavation. But few communities that have made a trial of moving materials by motor trucks and tractors will go back to the old method of using horses and wagons.

At the second annual meeting of the Northern Electric Engineering Society held at Montreal, the following officers were elected: Hon. President, P. F. Sise; President, W. S. Vipond; Vice-President, N. R. Ashley; Secretary, A. J. Lawrence; Treasurer, L. R. Waller. Committee, F. J. Benoy, W. B. Cartmel, J. Shields, J. O. Beaudet, F. H. Adler.

The Spanish River Pulp & Paper Co. has engaged an aeroplane to make an aerial survey of 1,000 square miles of forest north and west of Michipicoten. The aeroplane will be piloted by Captain Walter E. Lees, who will take with him on the trip Ben Avery and J. F. Regan of the Forestry Department and Milton S. Beal, photographer and executive officer.

* Paper read at the ninth annual convention of the Canadian Good Roads Association, Victoria, June 12-15, 1922.

EXPERIMENTS IN IMPROVING AND MAINTAINING OUR PRAIRIE ROADS*

Bituminous Deposits Awaiting Development — Characteristics of Prairie Soils — Experiments With Bitumen and Soils at Alberta University

By Dr. K. A. Clark,

Industrial Research Department, University of Alberta.

TWO closely related Alberta problems are being investigated at the Industrial Research Dept. of the University of Alberta, under the administration of the Scientific and Industrial Research Council of Alberta, Hon. Herbert Greenfield, chairman; namely, methods of improving our prairie roads and methods of development of the Athabasca bituminous sands. It is not obvious, at first sight, that these problems are related, yet, it seems probable that it is to the deposit of Athabasca bituminous sands that the prairie provinces should look to find the supply material that will act as a substitute for the stone and gravel materials used in the making of the well-known hard surfaced roads which are missing in the prairies. The bituminous sands contain an asphalt which, when separated from the associated sand and then mixed with prairie soil, quite profoundly changes the nature of the soil and makes it resistant to the unstabilizing action of water. Natural prairie soils, if at all clayey, take up water with avidity and promptly turn into a sticky, unstable mud that is the despair of both the traveller and the highway engineer.

Prairie Road Problem

The relationship between the prairie road problem and the bituminous sands is interesting. The prairie road problem is well-known; a tremendous mileage of highways; mud of the worst kind; generally speaking, no supplies of stone or gravel with which to make road surfaces; and not a large enough population or volume of traffic to warrant importation of materials to build the well-known hard surfaced roads at any cost. In connection with this road situation consider the other problem. In the north of the Province of Alberta there are about 15,000 square miles of country underlain by sand impregnated by asphalt. Large quantities of this bituminous sand are in plain sight along the banks of the rivers which have cut their valleys through the formation. This bituminous sand deposit is the largest of its sort so far found anywhere in the world. It is one of the big resources of Alberta. Two obstacles stand in the way of its development: first, the lack of an economical method of separating the asphalt from the sand so that the 85 per cent. of sand may be left in the north and only the 15 per cent. of the bitumen be shipped out; secondly, the lack of a sufficiently extensive use for the asphalt, when separated, to make feasible the establishment of development operations. The Industrial Research Department of the University of Alberta is searching diligently for a method of separation and if present favorable indications continue favorable, it will find one. It is in regard to the second obstacle that the connection between roads and bituminous sands arises. The big use for asphalt today is in road construction. Our prairie provinces need roads. If it can be discovered that by the use of reasonably small amounts of bituminous-sand asphalt, a type of prairie road adequate to the needs of the rural communities can be built economically, then a big outlet for asphalt from a bituminous sand will be open. The solution of the prairie road problem and of the tar sand problem are tied up together.

Colloid Content of Soil

The development of a type of prairie road with the aid of bituminous-sand asphalt will depend on an understanding of the properties of prairie soils. The outstanding property of prairie soils, from the road point of view, is

their mud-forming ability in presence of water. What is the reason of this mud-forming ability? Studies by soil chemists and physicists have assigned the reason to the colloid content of the soils. The term "colloid" need not introduce any mystery into the discussion. Everyday experience brings us all into contact with colloids. Two common examples are gelatine and glue. These substances are hard, and stable and when dry have marked binding qualities but when placed in water they swell to unstable jellies. In many places throughout Alberta, Nature has concentrated a natural colloid which, if it is not the actual colloid present in our prairie soils, must be very similar to it. I refer to "bentonite." Bentonite is a hard, almost stone-like material when dry, but in contact with water it swells to about eight times its dry volume into a sticky, unstable mass. Granted that bentonite or a similar type of substance is present in our prairie soils, it is not so hard to understand their hard, stable nature when dry and their marvelously quick change to unstable mud when they become wet. It is the presence of such a constituent in prairie soils which makes it so difficult to get a satisfactory sand-clay mixture for prairie roads. Many prairie soils are natural sand-clay mixtures, yet they soften badly when wet. The key to the situation is to find some way of modifying the soil colloid so that it will not swell in the presence of water, some way of keeping it always in its stable form.

Properties of Adsorption

There is a property of colloids which offers hope of accomplishing the result of modifying the soil colloid so that it will not so readily swell in water, the property of "adsorption." The term "adsorption" is probably still more mysterious than that of "colloid." There is no mystery about it however. Adsorption is a property which all matter, in the liquid and the solid form at least, possesses of condensing and tenaciously holding onto its surface a very thin layer of other substances with which the surfaces come into contact. Everybody has observed the working of this property. Why does a canvas tent shed rain? Because the dry canvas has a layer of air adsorbed onto the surfaces of all its fibres and the rain must first displace this adsorbed air before it can penetrate the canvas. Why does a shower penetrate such a little way into dry sand? Because the dry sand particles have a layer of air adsorbed onto their surfaces and this air must be displaced before the sand particles can be made wet by the rain. Colloids are made up of exceedingly small particles. The result is that a small amount of colloid has a tremendous amount of surface. Since adsorption is an effect that takes place on surfaces, adsorption is a very prominent property of colloids. If a fine soil such as a clayey soil is shaken up with a dye solution and this mixture placed on a filter, the solution which filters through is colorless. The soil particles, especially the very fine, colloid particles, have adsorbed the dye which was dissolved in the water and have left the water colorless. There are a host of substances that soil particles will adsorb in a similar manner to the way they adsorb the dye. If the soil particles could be brought into contact with some suitable substance, a substance, an adsorbed layer of which on the surface of the soil particles would prevent them from taking up water, then a remedy for the mud-forming propensity of soils would be in sight.

Experiments with Bitumen

Bitumen such as asphalt is a substance which repels water. Bitumen at once suggests itself as a substance to try to get adsorbed onto soil particles. Experiments tend to show that bitumen is adsorbed by the soil particles and that this adsorbed bituminous layer prevents the soil colloid from swelling in water. When the rather soft asphalt which is separated from the Athabasca bituminous sands is mixed with a wet soil, the asphalt readily works through the soil and is apparently distributed over the surfaces of the particles. When the wet soil into which the bitumen has been mixed dries out again, it is found that it has

*Paper read at the ninth annual convention Canadian Good Roads Association, Victoria, B.C., June 12-15, 1922

largely lost its ability to again take up water, at least at all readily. The quantity of bitumen that it is necessary to mix with the soil to accomplish this result varies, of course, with the clayey nature of the soil. Experiments at the University of Alberta have been made on a series of soils including a sandy soil from the south of the province, silty soils, a natural sand-clay mix and heavy clay soils. The method of test is very simple. A sample of the soil is made sufficiently wet with water so that it can be easily worked. The desired amount of asphalt, as separated from the bituminous sands, is added and worked through the wet soil. The sample is then compacted into a small wooden box and the top rounded off to imitate a miniature section of road and set away to dry. It is then exposed to wet conditions which are created by the spray from a garden hose. Samples are placed under the spray at the close of the afternoon and the result observed the following morning. By arranging a series of samples of the same soil containing varying percentages of bitumen, the advantage gained over the natural soil by addition of the bitumen, and the quantity of bitumen which must be added to render the soil stable against the artificial rain, are at once apparent. It is found that 5 per cent. by weight of the bituminous sand asphalt is sufficient for the sandy soils, from 5 per cent. to 10 per cent. for the silty soils while for the heavy clay soils 15 per cent to 20 per cent. is required. The bitumen for a heavy clay soil appears to be excessive. However, in a practical application, the proper procedure would be to make a sand-clay mix and incorporate into the sand-clay aggregate 5 per cent. of the bituminous-sand asphalt. The sand for admixture would not need to be a coarse sand, as is required for ordinary sand-clay construction, for the bitumen-treated clay will be stable under wet conditions as well as under dry conditions. If this scheme proves to be of practical value, the prairie road type may become, not the sand-clay type, but a modification of this type, a sand-clay-bitumen road.

The idea of using bitumen in a soil mixture especially in the way that has been described may seem novel to many but in reality it is not new. Oiling earth roads has been quite extensively practiced and has met varied success. A type of pavement called the "Bituminized Earth Pavement" was proposed a few years ago in the United States. It was made by incorporating about 17 per cent. of asphalt into dry, pulverized clay soil. The Bureau of Roads Progress Report for 1916 gives an account of an experimental piece of road construction very similar indeed to what we have been discussing. Hot asphalt was mixed into wet clay. The results were rather encouraging but the idea was not carried to a definite conclusion. Bitumen is also being used by the Bureau of Roads in experiments to stabilize subgrades for pavements. We do not claim and great share of originality for the work being carried on at the University of Alberta on the road problem. It is simply a case of trying to apply what has already been found out and what little else we can ourselves find out to local conditions which we have to face in our prairie provinces. Nature has not provided up with the material to build the well-known types of hard surfaced roads and we cannot afford to import these materials. Yet we need something better than the plain dirt roads, when the weather turns wet. If most prairie roads could be made to stay as stable when wet as they are when dry, our roads would be plenty good enough for our needs for some years to come. If we can get the asphalt out of the Athabasca deposit of bituminous sand cheaply, I believe that through its use it will be possible for the prairie provinces to make economical roads that will be serviceable whether it rains or shines.

The fifteenth general annual assembly of the Royal Architectural Institute of Canada will be held at Winnipeg, Man., on Monday and Tuesday, September 25 and 26, 1922. David R. Brown, Architect of Montreal is president and Alcide Chausse, Architect of Montreal is honorary secretary. Every practicing architect in Canada will receive an invitation to attend this important convention.

RATING AND TESTING ELECTRICAL MACHINERY

SUB-COMMITTEE of the Canadian Engineering Standards Association held its first meeting at Ottawa on June 16, with Prof. E. G. Burr in the chair. The chairman pointed out that the sub-committee had been formed to consider the advisability of the adoption or formulation of the C.E.S.A. of Canadian standardization rules for electrical machinery, covering the same ground as and preferably based upon, the rules of the American Institute of Electrical Engineers.

As a result of preliminary correspondence, it appeared that practically all the members of the sub-committee were in favor of the adoption of the A.I.E.E. rules, subject to such amendments or changes in arrangement as may be found desirable. This decision was confirmed by the meeting.

Discussion followed as to the best organization for the work, and three panels were appointed to deal respectively with the rules for rating and testing of:

- (1) Large motors, generators, and rotating machinery operating under controllable conditions;
- (2) Industrial sizes of motors and generators working under ordinary manufacturing or operating conditions,
- (3) Transformers of various types.

The existing transformer sub-committee would, of course, be consulted as regards the work of panel No. 3.

Consideration was given to the best method of keeping the sub-committee in touch with American committees working along the same lines, and it was decided that the fullest possible co-operation should be arranged for through the American Engineering Standards Committee.

QUEBEC ROAD POLICIES

SPEAKING at the Canadian Good Roads Association Convention recently, Hon. J. L. Perron, the new president of the Association, outlined the road policies of Quebec since 1912. He declared that the road program inaugurated in 1912 was now practically completed and that by next August there would not be a mile of road in the province that was not in first-class condition.

Quebec's policy in respect to municipal roads was to lend funds to municipalities at three per cent on a forty-one year basis, or pay 50 per cent. of the cost. Quebec spent \$1,000,000 on roads in 1912, before automobiles were a traffic factor, and during the war years the road appropriations were conservative, but in 1920 they advanced to \$5,000,000, and by the end of the present fiscal year about \$8,500,000 would probably be spent, he said.

We make our appropriations on the ratio of three dollars on the roads to serve rural communities to one dollar on provincial roads seeing tourists and pleasure seekers mainly, said Mr. Perron. We have carefully preserved that ratio and we find that not only are the farm districts well served, but we are able to carry out successfully, important highway projects for tourists as well. For instance, we put through a road to the White Mountains, another one to Maine, another to connect Montreal and Quebec, and so on. Tourist highway advocates are becoming more ambitious every year, and I hope to live to see the Canadian Highway complete from coast to coast.

Mr. Perron said he was a great believer in hard surface roads, but he warned that governments must not overburden the people with taxes. The liquor law of Quebec, he pointed out, attracted between 25,000 and 30,000 tourists over the roads to Quebec annually. The government realized that it was only fair to allocate a substantial proportion of the liquor profits towards road maintenance, and that recognition had been incorporated in the province's roads policy. The destruction of roads caused by the traffic of heavy motor trucks had resulted in the passage of a law prohibiting cars of more than two and a half tons from using the highways. Many of the highways were closed during the thawing season, he said, as a further precaution against wear and tear at a period when severe damage could be done.

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THE GOOD ROADS CONVENTION

SUCCESS crowned the efforts of the executive responsible for the program of the ninth annual convention of the Canadian Good Roads Association at Victoria, the report of which appears in this week's issue of "Canadian Engineer." In spite of the long distances that many delegates had to travel, the attendance was most satisfactory. Many excellent papers were read and the discussion brought out many interesting and helpful points. The fact that so many prominent men, engineers and public officials, gathered together for the definite purpose of discussing road problems, indicates that the success of the good roads movement is assured. As a result of this gathering more practical interest will be taken in highway construction, which must assist materially in the commercial development of Canada.

While conventions have certain advantages socially, one of the principal benefits comes from the interchange of ideas and the dissemination of knowledge. The good roads movement has received a decided impetus and each year will doubtless see an increasingly active interest taken in what has already become a national movement.

Millions of dollars will be expended on the construction and maintenance of roads in Canada during the next few years and it is very desirable that this money be spent to the best advantage. The first step is to educate public opinion to the necessity of good roads, so that money can be secured for this purpose. Conventions are most useful in this respect because of the publicity given the good roads movement. Roads must be built as economically as possible, consistent with good work, and those connected with

their construction and maintenance can derive much benefit from the papers and discussions at the conventions. The Hon. S. J. Latta, the retiring president of the association, in an able address, (printed elsewhere in this issue) brought out several interesting points regarding the construction, location and financing of highways. He referred to the many factors to be considered in road construction and emphasized the advantage of co-operation in solving road problems.

GUNITE ENCASEMENT OF STEEL BRIDGE STRUCTURES

THERE is now being built across the Willamette River at Oregon City, Oregon, a 360-ft. steel arch span which will undoubtedly attract the attention of very many bridge engineers. On account of the presence in the immediate vicinity of large industrial plants employing sulphurous anhydride, which has a pronounced deteriorating effect upon exposed steel, it was necessary to employ a protective coating for the steel of greater resistance than ordinary paint. After exhaustive study of many alternative types of structure, it was finally decided to construct the ribs of structural steel and to encase them with a thin coating of gunite. This is to be applied both on the exterior of the rib and on the interior. According to Engineering News-Record, the inside section is to be covered with a 3-4 in. gunite encasement and the exterior with wire mesh and an encasement of 1 1-2 in. of gunite finished with a carpet float.

With the increasing use of gunite for the protection of steel bridge structures, the engineering profession would welcome data concerning the resistance of these thin protective coverings of gunite to surface cracking. The efficacy of such a protective covering will entirely depend upon the ability of the gunite to preserve an unbroken surface. It is to be hoped that those engineers who have employed this material successfully will make known their methods by which they have combated the tendency of a thin mortar coating to crack at certain critical points.

LIMITATIONS TO WEIGHT OF RAILWAY EQUIPMENT

ALONG with the amazing increase in the weight of railway locomotives and cars, there has developed increasing criticism of the practice of carrying the weight of equipment to the present advanced state. For especially heavy traffic, locomotives of 400 tons weight are being employed, as for example, the Virginian 2-10-10-2 weighing 342 tons, and the Erie class P1-8-S-S-2 weighing 432 tons. While there is no doubt a saving in wages involved with the use of these immense locomotives, per thousand pounds of tractive effort, it should not be forgotten that the roadway maintenance resulting from their use and the cost of repairs to freight cars increase rapidly with the weight of the locomotive. When, with the use of powerful locomotives, the length of trains is increased beyond a certain point there is a tendency for the trains to break, for loads to shift and for damage to cars to become burdensome. Increased delays are also charged against very heavy locomotives, in one instance it being found that the time delayed due to car failures was twice as great with Mikado engine having a tractive effort of 57,000 lb. as with a Consolidation locomotive with a tractive effort of 39,000 lb.

Doubts are also expressed concerning the wisdom of building modern passenger and freight cars of enormous weights and carrying capacity. There are now in use coal cars of 120 tons capacity, and Pullman cars 90 ft. in length weighing approximately as many tons. The weight involved in the construction of a 90-ft. bridge structure as is found in the Pullman car is great as compared with that which would exist with a much shorter car. Some engineers express the view that with modern 100-lb. steel rails and with a track having 18 in. of stone ballast, the riding properties of much lighter cars would be satisfactory. There is the extra danger of destruction of cars in a

train through the presence in it of excessively heavy rolling stock. In addition, it is pointed out that the upkeep of tracks and bridges through very heavy cars is a charge that might be appreciably lessened without decreasing the popularity of a road by the use of lighter equipment.

PERSONALS

RUSSELL T. KELLEY, of Hamilton, was elected first vice-president of the Canadian Good Roads Association at the Victoria convention.

WALTER MAXWELL FINE of Edmonton, recently secured degree of Master of Science from the Massachusetts Institute of Technology.

F. L. FELLOWS, of Vancouver, was elected second vice-president of the Canadian Good Roads Association at the convention held in Victoria recently.

HON. JOSEPH LEONIDE PERRON, Minister of the Department of Highways for Quebec, was elected president of the Canadian Good Roads Association in the convention recently held in Victoria.

THOMAS MCMILLAN, vice-president of the Canadian Fairbanks-Morse Co., will succeed president HENRY J. FULLER, who resigned to become chairman of the Board of Directors. Mr. McMillan who is a native of Toronto, joined the Canadian Fairbanks-Morse Co. when 16 years old. His first important assignment with this company was that of credit manager of the Fairbanks-Morse Co. at St. Paul, Minn. In 1905, Mr. McMillan transferred to the headquarters of the Canadian Fairbanks-Morse Co., of Montreal, where he was appointed secretary of the company; subsequently being advanced to the directorate and to the position of vice-president.

OBITUARY

WALTER F. MERCER, contractor, died on June 15, aged 58. Deceased was born in Ayrshire, Scotland, and came to Canada when a boy, settling in Toronto, where he had lived ever since.

Engineer's Library

MANUFACTURE OF PORTLAND CEMENT

Reviewed by A. C. Tagge

Assistant General Manager, Canada Cement Co., Ltd.

MANUFACTURE OF PORTLAND CEMENT—By Arthur C. Davis, third edition, revised and enlarged, with 100 illustrations. Dublin, John Falconer. Flexible imitation leather; 6 by 9 in., pp. 416.

This is a third edition of an earlier work which the publisher announces has "been re-written and brought up to date by the insertion of matter dealing with the latest available information concerning the manufacture and testing of Portland cement, including a description of the newest labor-saving devices and testing appliances and methods, and the latest theoretical conclusions as to its constitution."

A more suitable title would be "Portland Cement" instead of "Manufacture of Portland Cement," as more than half of the book is devoted to chemical and physical testing specifications and uses.

The chapters on manufacturing deal almost entirely with materials, processes and equipment as used in the United Kingdom, and the Canadian reader will miss much that is common to modern mills on this side of the Atlantic. He will, moreover, find it hard to believe that this part of the book is representative of modern practice in the United Kingdom and this difficulty will be increased when he finds the rotary kiln referred to as "a new departure

in burning operations" and "a comparatively new method of cement manufacture."

Furthermore, some of the statements are misleading and some are incorrect in so far as manufacturing in this country is concerned. This part of the book would seem to have been brought up to date by the insertion of new material without the elimination of that which has become obsolete. For the reader who is familiar with modern practice, there is much that is interesting and suggestive, but for one who wishes to get a general idea of the manufacture as now carried on in this country, the book will be found disappointing.

The chapters on chemical analysis and on testing are excellent and contain many valuable observations on the effects of the various constituents and the relative importance of the different standard tests.

The chapter on "Sampling, Testing and Uses" contains a brief but interesting discussion on aggregates, proportioning, mixing and placing of concrete.

Other chapters that will be favorably noted are "Mineralogy of Cement," treating of the microscopic and crystalline structure; "Mechanism of Setting," presenting the crystalline and colloid theories; and "Fuel Valuation," giving methods of chemical analysis and calorimetric tests.

The appendix gives British, French and American standard specifications for Portland cement. There is an unusually full index.

AIR RECEIVERS AND AIR COOLERS. Bulletin K-310, recently issued by the Canadian Ingersoll-Rand Co., illustrating and describing air receivers of the vertical and horizontal types, and air coolers also of the vertical and horizontal types. The pamphlet will be found of considerable interest to all those who are engaged in any class of work in which compressed air is used.

ANNUAL REPORT OF THE TOPOGRAPHICAL SURVEY BRANCH FOR 1920-21. The report contains a record of the work done by this Branch according to the various locations. There are several appendices, one showing schedules for each surveyor employed, with the cost of work done by him. Appendix No. 4 gives the details of office work, while Appendix No. 5 shows the surveying instruments on hand on March, 21, 1921. Accompanying the report is a map designed to illustrate the progress of Dominion lands surveys. The report contains 56 pages.

STEAM TURBINES. A line of velocity-stage turbines especially designed for high pressure and high temperature steam is described in a 28-page catalog, 8 1/2 by 11 in., issued by the De Laval Steam Turbine Co., Trenton, N.J. The cast steel steam chest is located in the casing cover in order to avoid the conduction of heat to the bearings. In addition to the speed governor and governor valve, there is an independent valve controlled by an automatic over-speed trip. The turbines are built in sizes up to 1,200 h.p., and are designed to be directly coupled to high speed centrifugal pumps and blowers, small a.c. and d.c. generators, and, by means of double helical speed-reducing gears, to large pumps and blowers, medium-size generators, belt pulleys, rope sheaves and slow moderate speed machinery.

Contract for the St. John's, Winnipeg, telephone exchange of 6,600 lines has been secured by Siemens Brothers and Co., Ltd., Woolwich, London, Eng. Work was commenced in the factory at Woolwich immediately the contract was signed and early delivery is expected. This is, as far as is known, the first large installation of automatic telephone exchange equipment in Canada secured by a British firm and it is expected to be the forerunner of a permanent connection in this country. In addition to the above, Siemens Brothers and Co., Ltd. are constructing equipment for two or three small telephone exchanges in other parts of Western Canada. The Winnipeg order was secured for the British firm as the result of the initiative and work of the British Government Trade Commissioner resident in that city.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

BRIDGES, ROADS AND STREETS

Bathurst, N.E.—Word has been received by Town Clerk Strout from General Manager Kingsland, of the C.N.R. that it has been decided to recommend building of proposed concrete and steel overhead bridge where the spur line of railway intersects Murray St.

Belleville, Ont.—Hastings County Council approved of an expenditure this year on roads of \$125,700.

Birch Cliff, Ont.—Contracts for construction of sidewalks in Scarborough Township were awarded as follows: Danforth Ave., W. B. Hughes, 43 Victoria Park Ave., \$8,-031.66; Kingston Road, Kildonan Drive, Eastwood Ave., Birch Cliff Ave. and Audrey Ave., Grant Contracting Co., \$10,088; Pinegrove Ave. and Park St., A. Johnson, Fairmount Crescent, \$2,241. Other bidders on this work were: I. Scott & Son, 206 Silver Birch Ave.; National Contracting Co., Garniock Ave.; D. McKey, Ashdale Ave.; P. Licrasto, Toronto; A. Cavotti, Toronto; Maple Leaf Paving Co., Simcoe, Ont.; Britnell Contracting Co., Toronto; Goldie Construction Co., Toronto; Frank Angotti, Toronto; J. E. Jones, Toronto; F. Mattannia, Fergus, Ont.

Brantford, Ont.—Board of Works will probably recommend to City Council that a new road be built on Ava Road to city limits. City Engineer, F. P. Adams.

Bridgeburg, Ont.—The International Bridge Promotion Committee at Bridgeburg, of which Mayor W. T. Malkin is a prominent member, has decided to start activities immediately to bring about an actual start on the enlargement of the international bridge here.

British Columbia, Province of.—Contracts awarded by Highways Department to E. J. Palmer & Co. for paving two miles of the Yale Road in Langley Municipality. Concrete will be laid at a cost of about \$50,000.

British Columbia, Province of.—Provincial Public Works Department will shortly call for tenders for reconstruction of two sections of trans-provincial highway east of Creston. Estimated cost, \$30,000.

British Columbia, Province of.—A petition to the Government to have the money provided to carry out changes in the 25 miles of road from Princeton to Hope so that it will be suitable for a highway linking the coast and the interior of the province, is being signed by motorists in every community and will be presented to the Lieutenant-Governor for action.

Chatham, Ont.—City Council will petition the Ontario Government to construct 3 1-2 miles of the Provincial Highway east of Chatham during the present year.

Chatham, Ont.—City Council intends to construct asphalt pavement on St. Clair St., Cornhill St., William and Water Sts. at a cost of \$28,990.30; also granolithic sidewalks on King St., William St., Gladstone Ave. and Sheldon Ave. at cost of \$1,674.22. City Clerk, W. G. Merritt.

Drummondville, Que.—Contracts for structural steel in connection with construction of bridges at Bagot, Que., and Riviere Rouge, Valleyfield, Que., were recently obtained by the Walsh Plate and Structural Works, Ltd.

Dundas, Ont.—Work will start at once on repairs to streets and construction of concrete sidewalks. Town Engineer Murdoch will superintend the work.

East Nisouri Tp.—Contract for abutments for bridges at Lot 35, Townline between East Nisouri and West Zorra Townships, was awarded to A. Clifford, of St. Mary's, for \$1,185.

Edmonds, B.C.—The sum of \$15,000 is available from the Provincial Department of Public Works for work on

the Hastings-Barnet road this summer, providing Burnaby agrees to spend \$5,000 on the same highway.

Etobicoke Tp., Ont.—Contract for construction of concrete sidewalks on Douglas Ave. and Queen St. and grading on Queen St. awarded to A. Johnson at \$2,350.

Goderich, Ont.—Huron County Council granted town of Goderich \$26,000 for road construction on Victoria St. The estimates for county roads this year total \$173,800. Road Superintendent, T. R. Patterson, Goderich.

Halifax, N.S.—Works Committee recommended to City Council the laying of a concrete sidewalk on the east side of Brunswick St., from Buckingham to Duke.

Hamilton, Ont.—Wentworth St. is to be paved and car tracks relaid.

Hamilton, Ont.—City Council awarded contract for asphalt to the Warner Quinlan Co., at \$22.75 per ton.

Hamilton, Ont.—Hamilton & Wentworth Suburban Highways Commission awarded contract for laying 7,500 sq. yds. of 7-in. concrete roadway with crushed stone shoulders to the King Engineering & Construction Co., of Oakville, at \$25,383. Tenders were also received from the Frid Construction Co., the Canadian Engineering & Contracting Co. and Brayley & Patterson.

Hensall, Ont.—Tenders will be received until Wednesday, June 28, for the construction of 9,920 square yards of reinforced concrete pavement on King St. Plans and specifications may be seen at the office of T. R. Patterson, Engineer, Goderich, or A. Murdock, village clerk, Hensall, Ont.

Ladner, B.C.—Delta Council decided to widen Scott Road to 24 ft. and to construct concrete culverts across it. The road will be finished in hard surface some time during the next year. Clerk, N. A. McDiarmid.

Leaside, Ont.—York Tp. Council granted \$4,000 to the Town Council to expend on Bayview Ave., from Moore Ave. to Eglinton Ave.

London, Ont.—Hamilton Road, Dundas St. and Wharncliffe Road North will probably be paved this year. City Engineer, H. A. Brazier.

London, Ont.—City Council intends to construct a concrete walk on Rogers Ave. North, from Wharncliffe Road to Wilson Ave. City Clerk., S. Baker.

Markham, Ont.—Council awarded contract for concrete curb and gutter along Main St. to Willmot Shell, at 60c a ft. or total of \$4,560.

Mimico, Ont.—E. Huffman's tender for \$36,596 has been accepted for construction of pavement on a number of roads.

Montreal, Que.—Executive Committee asked City Council for \$10,762 for widening of Drolet St.

Montreal, Que.—City Council plans to pave 1,000 ft. on Craig St., between Bleury St. and Victoria Sq., with either granite blocks or asphalt.

Montreal, Que.—Instructions have been issued by the Executive Committee for the preparation of plans for reconstruction of Wellington St. subway, passing under G.T.R. tracks in Point St. Charles. City is also repaving Wellington St. this summer.

Montreal, Que.—Tenders will be received until June 26, addressed to the Executive Committee, for the construction of the following works: Paving—Des Erables St., from Amity to Sherbrooke Sts. Sidewalks—North side, Monkland St., from Melrose St. to Grand Blvd.; west side, Des Carrières St., from Laurier to Lamorichiere Sts. Pav-

ing and sidewalks—St. Donat St., from Sherbrooke St. to Lot 396-875. Paving—Monkland St., from Walkley to Montclair Sts., with sidewalk on south side of said street. Specifications may be obtained at office of the Road Branch Department of Public Works, City Hall.

Murrayville, B.C.—Langley Council voted a number of additional appropriations for road repairs. Clerk, R. A. Payne.

Nassagaweya Tp., Ont.—Contract for construction of bridge was awarded by Township Council to Butler & Palmer, of Guelph, at \$1,125.

Nelson, B. C.—De Wolf & Ham, contractors for construction of Ymir Road, awarded sub-contracts for grading to following: W. Olynk and G. Maglio, A. Larsen and G. Johnson, B. Blakeman, K. Mason and G. Anokski; Frank Nelson; H. Carver and L. Larsen; Thomas Tedford and Frank Brady; Oscar Nelson; L. Lindwell; W. Caroda; and A. Schulli.

Niagara Falls, Ont.—The Queen Victoria Park Commission has set aside \$100,000 for the completion of the Niagara Falls-Queenston boulevard.

Niagara Falls, Ont.—City Council intends to construct concrete walks on Lewis St., Ontario St., Liberty St., Spring St., Willmott St. and Third St. Clerk, W. J. Seymour.

Ontario, Province of.—The construction of a county-provincial road from the 6th Concession, Eldon, and the 3rd quarter road of Eldon to Fenelon Tp., is projected by the Councils of Ontario and Victoria Counties and the Provincial Highway Department.

Oshawa, Ont.—Ontario County Council passed by-law to raise \$20,000 for county roads and bridges.

Oshawa, Ont.—Town Council plans to extend Mechanic St. Engineer, W. C. Smith.

Oshawa, Ont.—Town Council accepted tender of Flint-off & Saunders for concrete sidewalks at 21 cents per sq. ft. and for crossings 24 cents per sq. ft.

Oshawa, Ont.—City Council intends to construct asphaltic concrete pavements on Albert St., Avenue St., Aberdeen St., Connaught St., Masson St. and Ritson Road, at a total cost of \$90,432.12. Clerk, F. E. Hare.

Oshawa, Ont.—Town Council awarded contract for asphalt concrete pavements to the Standard Paving Co., of Ottawa, at the unit price of \$3.36 per sq. yd. with an aggregate total of \$90,000. Other tenders were as follows: The Central Foundation Co. of Toronto, who bid on asphalt concrete pavements at \$3.44 per sq. yd., and also concrete pavements, at \$2.35 per sq. yd.; and John Carroll, of Peterborough, concrete pavements, \$2.35 per sq. yd.

Ottawa, Ont.—Road and bridge committee of Carleton County Council awarded contracts to Alex. Christie & Sons for erection of superstructure of North Gower bridge at \$1,648, and superstructure of Porteous bridge at \$3,456.50.

Owen Sound, Ont.—Work on Provincial Highway south of this city awarded to Frank Milligan & Co., of Iroquois, Ont.

Patricia, Alta.—Municipalities of Patricia and Iron Creek have already contracted with the Western Engineer and Construction Co., of Edmonton, for the building of 50 miles of road this year. In all probability there will be at least 100 miles built in these municipalities this year.

Pembroke, Ont.—Town Council intends to construct an asphaltic concrete pavement on Pembroke St. East, at an estimated cost of \$6,038.90. Clerk-Treasurer, S. L. Biggs.

Pembroke, Ont.—Town Council intends to construct bituminous macadam roadways on Hincks St., Trafalgar Road and Isabella St., at a total estimated cost of \$47,049.

Pembroke, Ont.—Town Council passed by-laws authorizing the construction of walk on west side of Centre St., from Metcalfe St. to Irving St., and for the grading and gravelling of the roadway on Doran St. Clerk, S. L. Briggs.

Port Stanley, Ont.—The assistance of the Dominion Government will be sought by Elgin County Council in repairing the west abutment of the Port Stanley bridge and in making the proper provision for erection of a lift bridge some time in the future. County Engineer James A. Bell,

St. Thomas, was instructed to prepare plans and specifications for the bridge repair and to advertise for tenders.

Quebec, Province of.—Contract for construction of Levis-St. Lambert highway (part in District No. 2) awarded to La Compagnie de Construction de St.-Ours.

Quebec, Province of.—Tenders for the construction of the Vaudreuil section of the Parrot Island bridge are to be called before the end of the month. Minister of Roads, Hon. J. L. Perron.

Quebec, Province of.—Tenders will be received by Hon. J. L. Perron, Minister of Roads, until one o'clock p.m., Friday, July 7, for the construction of a gravelled roadway on Chemin du Bord de l'Eau, Parish of St. Michel of Bellechasse.

Quebec, Province of.—Tenders will be received at the office of the Minister of Roads, Government Building, Quebec, Que., until one o'clock p.m., Tuesday, July 11, for construction of a gravelled roadway on portion of Joliette-l'Assomption situated in the parish of l'Assomption. Length, 11,687 feet.

Quebec, Province of.—Following contracts have been awarded by Highways Department for the resurfacing of portion of Charlotte Street School to Prost, Forde & Westell, a macadam on the Montreal-Ottawa Highway; L'Abord-a-Plouffe, Co. Laval; Kennedy Construction Co., Montreal; Ste. Dorothee, D. Lagace, L'Abord-a-Plouffe; Parish of Ste. Rose, West part, D. Lagace.

Quebec, Province of.—Tenders will be received at the office of Hon. J. L. Perron, Minister of Roads, Parliament Buildings, until one o'clock p.m., Saturday, July 8, for the construction of a gravelled roadway on those portions of Lambton road situated in the municipalities of the parish of St. Victor-de-Tring and of the village of St. Victor-de-Tring.

Quebec, Province of.—Tenders will be received by Minister of Roads, Government Building, Quebec, Que., until one o'clock p.m., Tuesday, July 11, for resurfacing of portions of Montreal-Ottawa Highway crossing the municipalities of the parish of St. Jerusalem, parish of St. Hermas, parish of Ste. Scholastique, parish of St. Augustine and parish of St. Eustache. Length macadam, 39,399 ft.; gravelling, 13,933 ft.

St. Francois Xavier, Man.—Tenders were received by C. A. Prefontaine, Sec.-Treas., until June 19 for the construction of five pile bridges on Portage Highway.

St. John, N. B.—Following tenders were received by the Highway Board for construction of concrete sidewalk in Lancaster: Saab & Moses, \$4,129.25; Harold Clarke, \$4,125.15; Perry Kelly, \$4,119.50; J. E. Kane, \$4,421.75; N. J. LaHood, \$4,043; Wheaton & Co., \$3,655.09; J. L. Feeny \$4,407.50; Maritime Construction Co., \$4,056.50.

St. Thomas, Ont.—Contract for steel work in connection with construction of a 300-ft. steel bridge on concrete foundations over Stalter's Gully on Nova Scotia St. in the Township of Malahide, County of Elgin, has been awarded to the Dominion Bridge Co. for \$21,397, and for the concrete work to J. S. Whitcomb, Windsor, for \$10,875.

Sandwich, Ont.—Essex County Council decided to spend approximately \$500,000 on road improvements this year. Work includes widening of river front road between Ojibway and Amherstburg. Road Supt., W. H. Kinster, Sandwich.

Sandwich, Ont.—Essex County Council passed bylaw providing for widening of the River Road in Sandwich West Township for a distance of 240 ft. south of Seminole Ave. Road Supt., W. H. Kinster, Sandwich.

Stamford Tp., Ont.—Township Council plans to construct a number of concrete sidewalks. Clerk, T. R. Stokes, Niagara Falls, Ont.

Sarnia, Ont.—Tenders were received by C. Hardy and L. W. Harkness, Commissioners, until June 20, for construction of a bridge over the Perch drain on Bridgen sideroad. Sarnia Tp., known as the Duncan Bridge.

Saskatchewan, Province of.—Contracts for construction of road from Esterhazy to Stockholm, and from Wroxton West 8 miles, were awarded to Fred Miles, of Regina, at \$9,105.50 and \$9,798, respectively.

Saskatchewan, Province of.—Contract for improvement of road from Kamsack north six miles has been awarded to the F. C. Hare Transfer Co., of Swift Current, and contract for improvement of road from Canora south to Burgis to John A. Jastremchi, Canora, Sask.

Tilbury, Ont.—Town Council awarded contract for pavement work for this year to the Chick Contracting Co., of Windsor, Ont. Approximately 14,000 sq. yds. of pavement will be constructed.

Toronto, Ont.—Board of Control accepted the tender of the Russell Construction Co., Ltd., for the Gerrard St. highlevel bridge, at \$721,519.38.

Toronto, Ont.—Civic Works Committee decided to recommend the City Council to authorize the widening of Young St., from Shaftsbury Ave. to Heath St., at a cost of \$925,000.

Toronto, Ont.—York County Council, at the request of the Department of Highways, passed a by-law to raise by levy \$150,000 for the construction of county roads and \$18,000 for maintenance.

Toronto, Ont.—York County Council awarded following contracts for construction of concrete structures: (1) Reinforced concrete bridge on townline of Markham and Whitechurch, Canadian Construction Co., Ltd.; (2) concrete breakwater on townline of York and Markham Townships, Gilbert S. Wright.

Toronto, Ont.—Surveys are now way on proposed extension of North Sherbourne St. to connect with Mount Pleasant Ave. through Moore Park. Following the survey an estimate of the new entrance to Moore Park and North Toronto will be made and submitted to the Works Committee, Board of Control and City Council.

Vancouver, B.C.—Contract for electrification of Granville Island was awarded by Vancouver Harbor Commission to W. W. Fraser. There were nine tenders received.

Vancouver, B. C.—City Council awarded contract to the Western Construction & Paving Co. for asphalt penetration at \$1.34 per sq. yd. and for oil penetration at \$1.80 per sq. yd. The Columbia Bitulithic Co. was awarded contract for hard-surfacing at \$1.46 per sq. yd. and \$5 per batch of asphalt mixed.

Vaughan Tp., Ont.—Contract for construction of Tibbitt's Bridge awarded to Lewis Construction Co.

Verdun, Que.—Council gave first reading to a by-law authorizing the borrowing of \$175,000 for the paving of Verdun and Mullarkey Streets.

Waterloo, Ont.—Town Council intends to construct bituminous pavements with concrete curbs and gutters on the following streets: Allen, Willof and Erb Sts. Estimated cost, \$38,077. Clerk, James C. Haight.

Westborne, Man.—Tenders will be received until 2 p. m., Friday, Jun 30, by A. M. McGregor, Sec.-Treas., Westbourne Municipality, Gladstone, Man., for grading. Specifications may be obtained from the Secretary-Treasurer, or at the office of the Good Roads Board, Winnipeg.

Westmeath Tp., Ont.—Contract for construction of reinforced concrete culvert and approaches on Bellow's Creek, has been awarded to Forin & Lassman, of Pembroke, for \$7,912. Five tenders were received, the highest being for \$13,637.

Windsor, Ont.—Plans for a bridge which would span the Detroit River at Walkerville and could be erected at a cost of from \$8,000,000 to \$11,000,000, depending upon the details of the specifications, were received by Mayor H. W. Wilson from Denis O'Meara of Detroit.

Woodstock, Ont.—Council awarded contract to George Wilks, of this city, for construction of sidewalks, curbs and gutters, at 73c per ft. for curb and gutter, 15c per ft. for concrete sidewalks, \$27.50 each for catch basins, \$1.75 per load for extra filling, 75c per lin. ft. for connections, and 20c per sq. ft. for crossings.

WATER, SEWAGE AND REFUSE

Amherstburg, Ont.—Contract for installation of watermains was awarded to the Webster Construction Co.,

of London, for \$14,440. Other bidders were as follows: H. L. Robidoux, Amherstburg, \$16,271; Aindani Co., Windsor, \$16,113; Palumbo Contracting Co., Windsor, \$17,605.95; Pettypiece, Ltd., Amherstburg, \$17,367.

Chatham, Ont.—City Council intends to construct glazed tile sewers on Cornhill St., Water St. and Pegley St., at a total cost of \$2,585.90, City Clerk, W. G. Merritt.

Edmonton, Alta.—City Council intends to construct sewer extensions in four lanes. City Clerk, C. E. K. Cox.

Edmonton, Alta.—Contracts for construction of 12,300 lin. ft. of sewer in the Highlands Subdivision was awarded by City Council to the Permanent Construction Co., 826 Telgar Building, Edmonton.

Edmonton, Alta.—City Commissioners recommended to City Council that contract be awarded to Jackson & Webster, Edmonton, for approximately 16,000 lin. ft. of watermain in Bellevue addition, at \$10,457. Other tenders received: C. L. Devall, \$11,752; Benson & Benson, \$13,013; Wilson, Southworth & Wilson, \$14,356; Martinovich, \$19,142; H. E. Jamieson, \$14,425; W. J. Graham, \$14,447.

Etobicoke Tp., Ont.—Ontario Railway and Municipal Board approved plans for proposed water area to supply Etobicoke Tp. It will cost approximately \$55,000 to install the system.

Kitchener, Ont.—Water Commission authorized the laying of a 6-in. main on Lydia St., from Frederick St. for 370 feet easterly, and for a 4-in. main on Mary St., from near Pine St. to the Waterloo boundary. Superintendent, M. Pequegnat.

Montreal, Que.—Tenders addressed to the Executive Committee will be received at the City Hall Annex until June 29 for construction of sewers in Lepailleur and Walkley Sts. Specifications may be obtained at office of Sewers Branch, Public Works Dept., City Hall Annex.

North Vancouver, B. C.—Ratepayers passed sewer by-law. Clerk, John G. Farmer.

Oshawa, Ont.—Town Council authorized Town Engineer W. C. Smith to call for tenders for completion of Westmount sewer.

Ottawa, Ont.—Tenders close June 27 for construction of Emmett St. sewer. Commissioner of Works, A. F. Macallum.

Peterboro, Ont.—Contract has been awarded to the Northern Foundry & Machine Co., Ltd., Sault Ste. Marie, Ont., for a single-stage double-suction centrifugal pump of 8 million gallons daily capacity, for the filtration plant.

St. John, N. B.—A new water main to West St. John is proposed.

St. John, N.B.—Contract for cast iron pipe for city was awarded to T. McAvity & Sons, of this city. Tenders were also received from Vroom & Arnold, representing the Canada Iron Foundry; Francis Hankin, Montreal; Drummond McCall Co., Montreal; B. & S. H. Thompson, Montreal; and Canadian Fairbanks-Morse Co., St. John, N.B.

Sandwich, Ont.—Town Council plans sewerage system for south-eastern section of town. Town Engineer, C. R. McCall.

Sarnia, Ont.—Sewer pipes will be laid shortly in the big ditch on Talfourd St., between Ontario and Gibson Sts., and the ditch will be filled in and the roadway graded. City Engineer, W. V. Taylor.

Tecumseh, Ont.—Town Council has taken over Eau Claire Water Works system and will install a filter plant at a cost of approximately \$9,000. Clerk, Ernest Dugal.

Tilbury, Ont.—Town Council awarded contract for sewer construction this year to the Chick Contracting Co., of Windsor, Ont.

Toronto, Ont.—Civic Works Committee recommended to Board of Control purchase of Dufferin-Emerson Ave. site for construction of incinerator.

Welland, Ont.—Contract for construction of sewers on Margaret St., Nye Ave. and Queen St. West was awarded to C. J. White, Welland, at \$1,990.80. Tender was also received from Somerville & Dilworth, Welland, at \$2,088.32.

York Tp., Ont.—Township Council gave first reading to a by-law providing for installation of a 12-in. trunk main on Hillary Ave.

York Tp., Ont.—The question of a water supply from Scarboro for York Township, eastern section, is closed as far as the Scarboro authorities are concerned, according to the statement of an official. York Township has declined to pay the price demanded by Scarboro. The available supply of water at Scarboro water works is 150,000 gallons a day, the plant being capable of pumping 7,000 perhour.

LIGHT, HEAT AND POWER

Aroostook Falls, N.B.—Contract awarded to D. C. Burpee & Son for building power plant for the Maine & New Brunswick Power Co.

Belle River, Ont.—On July 13 by-law will be submitted to ratepayers authorizing the raising of \$13,500 for construction of electrical distributing plant. Village Clerk, A. Lacharite.

Chippawa, Ont.—The transformer station of the Ontario Hydro-Electric Power Commission was destroyed by fire. Six transformers were destroyed. Estimated loss, \$200,000.

Guelph, Ont.—Board of Light & Heat Commissioners approved an application for a gas main on Mount and Bagot Streets.

Lindsay, Ont.—Hydro-Electric Power Commission of Ontario plans to rebuild the distribution system here this season in the district south of Kent St.

Sault Ste. Marie, Ont.—Hydro-Electric Power Commission of Ontario will send an engineer here to make a survey of the power still available in the rapids and prepare an estimate of the cost of developing it.

RAILWAYS

Brantford, Ont.—Grand Trunk Railway Co. plans erection of new station at West Brantford.

Fort William, Ont.—Contract for construction of new yard office for Canadian Pacific Railway, Co. has been awarded to J. McDiarmid & Co., Ltd., Winnipeg.

Guelph, Ont.—City Council authorized expenditure of \$150,000 on Guelph Radial Railway.

Guelph, Ont.—Program of improvements contemplated by the Hydro-Electric Power Commission of Ontario on radial system calls for an expenditure of \$116,379.

Lachine, Que.—Council decided to ask the Grand Trunk Railway Co. to build a central railway station between 15th and 20th Avenues.

Oshawa, Ont.—Oshawa Railway Co. has been authorized to construct a passing track on Simcoe St., 100 feet south of John St., to Metcalfe St.

Ottawa, Ont.—A bill respecting the Edmonton, Dunvegan & British Columbia Railway, introduced first in the Senate, was reported from the House Committee on Railways recently. The company is authorized to extend its Grand Prairie branch for a distance of approximately 50 miles southwest.

St. Stephen, N. B.—Preliminary surveys for a line of railway from Black's Harbor, Charlotte County, to connect with the shore line division of the C.P.R., at Pennfield, are to be commenced at once by A. E. Hanson, Civil Engineer of Fredericton, for Connors Bros. Ltd. Length, 11 miles.

Sandwich, Ont.—Essex County Council granted permission to the Hydro-Electric Railway System to construct two spurs across the river road in Sandwich West Township.

Toronto, Ont.—The report of the year 1921 of the Canadian National Railways, just issued, shows that there still remain 584 miles of line that has been graded but which has no track.

FACTORIES AND LARGE BUILDINGS

Birch Cliff Heights, Ont.—Scarboro Township branch of the G.W.V.A. decided to build a hall at the corner of

Kildonan Drive and Kingston Road at a cost of \$6,000. Contract has been let to A. Bishop.

Brandon, Man.—Plans are being prepared for new science building for Brandon College. Estimated cost, \$125,000. Tenders will shortly be called.

Bridgeburg, Ont.—Town Council accepted plans of Architect C. M. Borter, of Niagara Falls, Ont., for proposed new Town Hall. Estimated cost, \$30,000. Tenders will be let on July 3.

Burlington, Ont.—E. A. Harris, editor of the Burlington "Gazette," announced that he would likely build a new office building in the near future.

Deseronto, Ont.—W. H. Harvey has been awarded the contract for remodelling the public school, for approximately \$12,000.

Dixie, Ont.—Trustees of S. S. No. 1 decided to erect new school house.

Drummondville, Que.—Contracts for structural steel work in connection with following buildings were recently secured by the Walsh Plate and Structural Works, Ltd.: City Hall & Fire Station, St. Guillaume, Que., College of Immaculate Conception, Montreal; extension, Montreal Cottons, Valleyfield, Que.

Edmonton, Alta.—Formal approval of plans for the new public library has been given by the Carnegie Corporation of New York. Tenders will be called. Estimated cost, \$150,000.

Edmonton, Alta.—Tenders will be received by William G. Blakey, Architect, Canada Permanent Bldg., until noon, June 30, for general contract, heating and plumbing and electric wiring for the Children's Aid Boarding Home Edmonton.

Ford, Ont.—School Board awarded contract for erection of Charlotte Street School to Prost, Forde & Westell, 3 Ouellette Ave., Windsor, at \$123,000.

Fort Frances, Ont.—Contract for construction of High School awarded to the John East Co., Ltd., Fort Frances, for \$62,700.

Port Mann, B. C.—A two-room school is to be erected at a cost of \$5,000.

Fort William, Ont.—Work is to be started immediately on addition to plant of Fort William Paper Co.

Fort William, Ont.—The Raymond Concrete Pile Co., Ltd., Montreal, have been awarded contract for the driving of 2,100 Raymond Concrete piles for the Fort William Paper Co.

Fort William, Ont.—City Council plans expenditure of approximately \$150,000 for construction of a new public school in the Wayland Addition and a four-roomed addition to the Ogden Street School.

Galt, Ont.—General Manager U. W. Kirkwood, of the Lake Erie, Northern & Grand River Railway, announced that early in July work would be started on the new union depot on Main St. The plans have been finally approved and tenders are now being called for.

Gleichen, Alta.—Tenders for the erection of a school building by the trustees of the Living Spring School District No. 3119, will be received until July 4. Plans and specifications may be obtained from the Department of Education, Edmonton, or from A. N. McLeay, Sec.-Treas.

Hamilton, Ont.—Alterations involving an expenditure of \$50,000 will be made to the McKay building, King St. East, which has been acquired by the L. R. Steel corporation.

Kingston, Ont.—Tenders will shortly be called for isolation building at General Hospital.

Kirkland Lake, Ont.—The Bedgood Gold Mine Ltd., head office, Haileybury, plan erection of mill.

Kitchener, Ont.—Erection of \$30,000 addition to seminary was discussed at recent meeting of Evangelical Lutheran Synod.

Kitchener, Ont.—Contract for erection of collegiate and vocational school let to Anglin-Norcross, Ltd., Toronto, and contract for heating, plumbing and ventilating to Purdy Mansell Ltd., of Toronto.

Lachine, Que.—A Montreal firm plans construction of a refrigerating plant here.

Leamington, Ont.—Tenders are being called for construction of new Baptist Church.

Leamington, Ont.—High School Board propose to erect addition to High School costing \$65,000.

London, Ont.—Plans are being prepared for erection of four-story amusement hall to cost approximately \$100,000. Address Building Inspector Piper.

Melbourne, Ont.—Contract for erection of brick continuation school let to D. J. McEachern, of Alvinston, for \$15,475.

Montreal, Que.—The Raymond Concrete Pile Co., Ltd., Montreal, have been awarded contract for the foundation of the Dominion Linseed Oil Co., Ltd., plant on mill St.

Montreal, Que.—As authorized by the Legislature the city executive recommended to City Council that the sum of \$1,500,000 be borrowed for the construction and furnishing of a new City Hall.

Montreal, Que.—Tenders were received by the Catholic School Commission, Western District, until June 26, for construction of St. Zotique School—girls' section—and of a residence for Nuns. Director-Secretary, J. David Pilon.

New Westminster, B. C.—Pacific Starch Products, Ltd., plan erection of plant at South Westminster, work to be done by day labor.

New Westminster, B. C.—Contract for the remodelling of and improving of St. Andrew's Church hall was awarded to Sloane & Harrison, of New Westminster. Cost, \$8,000.

Oakville, Ont.—The Oakville "Star" and the Oakville "News" will erect new buildings this summer.

O'Leary, P.E.I.—Tenders for building Presbyterian Church will be received by A. J. Matheson, Secretary, until June 30. Plans and specifications may be seen at office of Chappell & Hunter, Charlottetown; the Pioneer Office, Summerside; and at A. J. Matheson's drugstore, O'Leary.

Oshawa, Ont.—Board of Education engaged Hutton & Souter, architects, of Hamilton, for prepare plans for a 14-roomed school to cost \$105,000, and an 8-roomed school to cost from \$60,000 to \$65,000.

Ottawa, Ont.—Contract for concrete floor, main building, Lansdowne Park, was awarded to John Campbell, 3877 Frank St., Ottawa, at \$1,923.

Ottawa, Ont.—Plans for the construction of the stadium for Stadium of Ottawa, Ltd., have been completed. President, Dr. J. L. Chabot.

Ottawa, Ont.—Plans for proposed new church for congregation of St. Matthew's church have been accepted and tenders will be called. Rector, Rev. Canon G. S. Anderson.

Prince Rupert, B. C.—A. M. Pegers, architect, Edmonton, Alta., will act in a consulting capacity for both City Council and School Trustees in connection with new quarter million dollar High School and other school buildings.

Regina, Sask.—Contract awarded to the McKay Building and Engineering Co., Ltd., for construction of a business block on Dewdney St. at a approximate cost of \$15,000.

Regina, Sask.—Local Government Board authorized construction of new schools at following places: Hoggy Creek, \$5,500; Devon, \$4,000; Tunbridge Wells S. D., near M'lessis, \$3,400; Ardill S. D., at Ardill, \$2,400.

Rocky Mountain House, Alta.—Wilson Block was destroyed by fire. Loss, \$20,000.

Sarnia, Ont.—Tenders closed June 24 for masonry, carpentry work and plastering in connection with improvements to the second and third stories of the Industrial Mortgage and Saving Building. Manager, D. N. Sinclair.

Tatamagouche, N.S.—Fire destroyed the sash and door factory of J. Honneyman & Sons. Loss, \$15,000.

Three Rivers, Que.—Raymond Concrete Pile Co., Ltd., New Birks Building, Montreal, have been awarded contract for the piling for the St. Lawrence Paper Company's plant by Thompson-Starret Co.

Thurlow Tp., Ont.—Contract awarded to Thomas Manley & Son for erection of four-roomed school. Cost, \$30,000.

Tillsonburg, Ont.—High School Board plans addition to High School costing \$25,000.

Toronto, Ont.—Members of St. Monica's Church will start campaign to raise \$10,000 for new church. Rector, Rev. Gore M. Barrow.

Toronto, Ont.—C. W. Scaife, 31 Ennerdale Road, rector of the "Free" Church of England, plans erection of church in vicinity of Ennerdale and Hatherley Roads.

Toronto, Ont.—Tenders were received until June 26 by Board of Education for (1) all trades and electric wiring for Frankland School, Caretaker's House; (2) hardware for Dufferin School.

Toronto, Ont.—Plans for the new First Avenue Baptist Sunday School building to cost \$40,000, are progressing according to the pastor, Rev. Dr. W. T. Graham, and an early start is expected.

Toronto, Ont.—Don Valley Brick Co. has taken out a permit for a \$7,000 building, and the Don Valley Paper Mills will erect a \$10,000 one-storey building to replace part of the plant destroyed by fire recently.

Vauxhall, Alta.—Goderlig & Jacobson, of Enchant, has been awarded the contract for erection of school.

Victoria, B. C.—Tenders will be called by Secretary of Jubilee Hospital, for inside partitions and ventilation system for Jubilee Hospital.

Victoria, B.C.—Contract for rebuilding Arcade Building, recently destroyed by fire, has been awarded by David Spencer, Ltd., to Luney Bros., at approximately \$85,000.

Welland, Ont.—Plans for construction of Free Library, prepared by N. A. Kearns, architect, were approved by the Library Board.

West Burnaby, B.C.—Contract was awarded to Ward & Leverington, Edmonds, B.C., for erection of High School, for approximately \$30,034.

Windsor, N. S.—Directors of Edgehill School plan erection of a new wing.

Windsor, Ont.—Board of Education decided to construct an addition to Wyandotte Street School.

Windsor, Ont.—Plans for new building for The Border Cities Star at the southwest corner of Pitt and Ferry Sts. are nearly completed and tenders will be called shortly. Owner, W. F. Herman; architect, A. H. McPhail.

Winnipeg, Man.—Fire damaged the St. Boniface Orphanage to the extent of \$40,000.

Woodbridge Heights, Ont.—Members of Lodge Coleridge, S.O.E., plan erection of hall.

MISCELLANEOUS

Atwood, Ont.—Tenders will be received until 2 o'clock p.m., Saturday, July 8, by Geo. Lockhead, Clerk, Township of Elma, Atwood, Ont., for construction of drainage work in Elma Tp. known as "The Boyle Drain and South Maitland River Improvement." Estimated cost of work, \$81,113.90.

Berwick, Ont.—Tenders will be received at office of J. A. Robinson, Reeve of Finch Tp., Finch P.O., until 12 o'clock noon, Monday, July 3, for construction of Whiskey Creek Drain in Township of Finch and Cambridge. Length of drain to be excavated—Main 29,600 ft.; branch, 8,300 ft. Volume of excavation—Main, 5,486 cu. yds.; branch, 2,189 cu. yds. Culverts—One 24-in. tile, 15 ft. long; one cedar culvert, 6 ft. clear. Plans and specifications may be examined at once of Reeve, or at office of D. H. Weir, Civil Engineer, Winchester, Ont.

Brantford, Ont.—Board of Works recommended that Brant Ave. and the Ava Road, between St. Paul Ave. and westerly limit of O.S.B. grounds, be paved and a storm sewer constructed, according to the report of City Engineer E. P. Adams.

Cumberland, Ont.—Tenders will be received until July 3 by W. W. Dunning, Clerk, Cumberland, Ont., for excavation of Shaw's Creek Drain. Estimate of quantities—31,419 cu. yds. earth excavation; 19 cu. yds. rock excavation. Specifications may be examined at office of W. H. Magwood, Civil Engineer, Cornwall, Ont.

East Oxford Tp., Ont.—Tenders will be received by F. G. Jackson, Township Clerk, Oxford Centre P. O., Ont., un-



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til 12 o'clock noon, July 3, for construction of the Underhill Drain.

Guelph Tp., Ont.—Township Council awarded contract for construction of two concrete culverts to Herb Quarrie. By-law permitting construction of intercepting sewer on Waterloo Ave. was approved. Purchase of stone crusher is being considered by Council. Clerk, James Laidlaw, Guelph.

Halifax, N. S.—An issue of debentures amounting to \$390,700 is being issued by city for construction of sewers, pavement, sidewalks, water extensions, curbs and gutters, widening streets and new street lighting services. City Treasurer, James J. Hopewell.

McKillop Tp., Ont.—Contract for construction of Canada Co. drain was awarded to McDonnell Bros., Stratford, at 28 cents per cu. yd., or total of \$5,689.60. Highest tender was \$7,500. Tenders were also received from: Wm. Connelly, Logan Tp.; Geo. Arbuckle, Toronto; John Reid, Logan Tp.; E. P. Murray, Stratford; Wilbert Drury, Arthur, Ont.; and Gaunt Gaffney, Logan Tp.

Moose Creek, Ont.—Contracts for McIntosh Branch of North Branch Drain awarded to Hugh Kennedy, of Monckland, at 25 cents per cu. yd. for earth and \$1 for hardpan. Amount of excavation, 1,286 yds. earth and 92 yds. hardpan. Tenders were also received from: Stephen McDonald, Apple Hill, Ont., and S. Gauthier, Moose Creek.

Moose Creek, Ont.—Tenders for construction of the Blair and McRea drain, Legault drain and McGregor drain, will be received at office of Murdoch McLeod, Clerk, Township of Roxborough, until 10 o'clock, June 28. Plans and specifications may be examined at office of Township Clerk, Moose Creek, Ont., or at office of D. H. Weir, Engineer, Winchester, Ont.

New Westminster, B. C.—Contract for construction of concrete retaining wall on Front St. awarded by Provincial Dept. of Railways to Robertson & Rendell, Vancouver, at \$45,000.

Ontario.—The following are the names of companies recently incorporated under provincial charter, with head office, capitalization and name of one director: Aladdin Electric, Ltd., Hamilton, \$150,000, MacNeil, C. MacNeil; Belleville Electric & Stamping, Ltd., Belleville, \$40,000, Arthur B. Turner; Big Dyke Consolidated Gold Mines, Ltd., Toronto, \$10,000,000, Ralph J. Haffey; Federal Buildings Corporation Ltd., Toronto, \$1,000,000, Norman L. Mathews; Jarvis Gold Mines, Ltd., Toronto, \$50,000, Donald E. Lewis; Millions Lake Gold Mines, Ltd., Toronto, \$2,000,000, Jos. Montgomery; National Chemical Compounds, Ltd., Toronto, \$75,000, Henry H. Davis; Tubing & Moulding Co., Ltd., Toronto, \$40,000, Edward A. Richardson.

Ontario.—The following are the names of companies to which provincial charters have been granted, with head office, capitalization and name of one director: American Matachewan Gold Mines, Ltd., Toronto, \$2,000,000, John D. Bradford; Anglo Porcupine Gold Mines, Ltd., Toronto, \$3,000,000, Mervil MacDonald; Cryster Machine Works, Ltd., St. Catharines, \$40,000, Philip I. Price; Dominion Electric Manufacturing Co., Ltd., Toronto, \$60,000, Wilfred Field; Harvey Kirkland Mines, Ltd., Toronto, \$5,000,000, David I. Grant; K-T Foundry, Ltd., Galt, \$100,000, Jas. R. Fergusson; London Metal Products, Ltd., London, \$60,000, Chas. A. Harris; Gordon Murray Gold Mines, Ltd., Toronto, \$2,500,000, Richmond W. Hart; South Argus Gold Mines, Ltd., Toronto, \$2,000,000, Thos. R. Kerr.

Ottawa, Ont.—House of Commons voted \$8,000,000 for work on Welland Canal.

Ottawa, Ont.—House of Commons voted \$50,000 for surveys and investigations on the St. Lawrence ship canal project.

Ottawa, Ont.—Government voted \$210,000 for Trent Canal construction and betterments and \$550,000 for improvements.

Ottawa, Ont.—Hydro-Electric Commission of the City of Ottawa awarded contracts for brickwork and masonry

to John Sutherland & Son, and contract for supply of wire to the Garrioch Godard Co.

Ottawa, Ont.—Members of the House of Commons representing Toronto constituencies intend to submit to Hon. J. H. King, Minister of Public Works, a request that the Dominion Government undertake this year additional work for the protection of the shore of Toronto Island, which is being worn away by the action of the waters of Lake Ontario. They will ask that a further sum of \$200,000 be placed in the supplementary estimates, to be submitted to Parliament for the prosecution of the undertaking, which will include the extension of the breakwater at a cost of \$175,000.

Pointe Claire, Que.—The town will shortly offer bonds amounting to \$400,000 for projected extension of water mains, sewers, sidewalks and roads.

Quebec, Que.—Public Works Committee decided to repair ferry boat wharf at cost of \$5,000.

Quebec, Que.—Public Works Committee decided to install a fire prevention system in City Hall at cost of \$4,000.

St. Catharines, Ont.—Dominion Government Dept. of Public Works awarded contract to Peter Lyall Construction Co., of Montreal, for completion of sections three and four of the Welland Ship Canal.

St. Thomas, Ont.—Elgin County Council adopted recommendation of County Engineer James A. Bell to improve the creek at the approach to the Catfish Creek bridge, between South Dorchester and Malabide.

Saskatchewan, Province of.—Lt.-Col. A. J. McPherson has been sent out by the Department of Highways to investigate the economic feasibility of a large drainage scheme in the Carrot River country in the northeast of the province. Estimated cost, \$324,960.

Saskatchewan, Province of.—Thousands of acres will be reclaimed in Saskatchewan this season when the several drainage schemes under the Department of Highways are carried out. The work which is being undertaken in various parts of the province will cost the provincial government about \$50,000.

Thessalon, Ont.—Tenders addressed to John Coulter, Town Clerk of Thessalon, will be received up to July 8, 1922, for the supply of and erection of (a) 200 h.p. water turbine with governor directly connected to a 175-k.v.a. generator, complete with switchboard and exciter, etc.; (b) construction of dam, head works, 48-in. wood stave pipe line, power house and tail race. Plans and specifications may be seen at the office of the consulting engineer or of the town clerk, Thessalon. Set of plans and specifications may be obtained from the engineer upon deposit of \$10. John O. Coulter, Clerk and James, Proctor & Redfern, Toronto, Engineers. (See official adv.).

Toronto, Ont.—York County Council decided to relay flooring of Don Valley bridge and also lay a tile drain on Pape Ave., from Aldridge Ave. to Cronin Ave.

Vancouver, B.C.—Two projects involving the expenditure of over \$1,300,000, have been commenced by the B.C. Electric Railway Co., one being the construction of a new 640-ft. dam and the rebuilding of the present dam at Stave Lake, permitting the addition of a fourth power unit, to cost \$1,250,000, and the other being the extension of the Broadway West line, in the city, to cost some \$75,000.

West Luther, Tp., Ont.—Contract for construction of municipal drain containing 20,300 cu. yds. awarded to Archibald Construction Co., Ltd., Toronto, at 26 cents per cu. yd. Other tenders received: Robert Longe, 34 cents; Segaworth & Dobbs, Damascus, 28½ cents; Chas. Van Slambrouck, Blenheim, \$6,000; Wilbert Drury, R. R. No. 2, Arthur, 30 cents; Laurie Gaunt, Arthur, 39 cents; McDonnell Bros., 12 Pandora Ave., Kitchener, 39½ cents.

Winnipeg, Man.—A provincial charter has been granted to the Winnipeg Clay Products, Ltd., capitalized at \$500,000. Director, Alex. Morrison.

York Tp., Ont.—Township Council approved some 56 local improvement by-laws.

ROADS, BRIDGES AND STREETS

(Additional)

Barton Tp., Ont.—New tenders are being received for building of roads and laying of sidewalks. Tenders close June 30. Clerk, A. G. E. Bryant, Court House, Hamilton.

Brantford, Ont.—Road and bridge committee of Brant County Council is considering construction of bridge on county road west of Burford. County Engineer, A. M. Jackson, Brantford.

East Gwillimbury Tp., Ont.—Contract awarded to Hector Patterson, Gormley, Ont., for construction of concrete bridge.

Etobicoke Tp., Ont.—Contracts were awarded to G. S. Wright for construction of two reinforced concrete culverts.

Ford City, Ont.—Town Council intends to widen Strabane Ave., from Erskine St. to Sandwich St., to a width of 70 ft., at a cost of \$4,125. Clerk, J. F. Foster.

Hamilton, Ont.—Board of Control recommended to City Council that contract for cement mixer be awarded to Koehring Co. of Canada, Toronto, at \$6,525. Other tenders received: Dominion Industrial Products Co., \$5,360.37; St. Clair Concrete Machinery Co., Galt, \$2,635; Whettlauffer Bros., Toronto, \$5,300; London Concrete Machinery Co., \$5,000; F. H. Hopkins Co., \$7,487; Mussels, Ltd., \$8,466; E. J. McHaig Co., \$8,350.

London, Ont.—City Engineer H. A. Brazier announced that one mile of paved streets will be constructed this year in west London at a cost of \$45,000.

Mlniota, Man.—Contract for placing of concrete pipes and building headwalls in roads constructed during 1922, awarded to D. C. McDougall, Virden, Man. Other bidders were: T. W. Manser, Virden; F. W. Bridger, Brandon; W. H. Hannan, Virden.

Owen Sound, Ont.—Contract for approximately 1,500 sq. yds. of concrete pavement awarded to Mackenzie & Symonds, Wiarton, at \$1.86. Other tenders received: Dewar Bros., Owen Sound, \$2.49; Clark & Son, Owen

Sound, \$2.51; and Bryson & Irwin, Wiarton, \$2.60.

Pembroke, Ont.—Town Council adopted report of Board of Works recommending construction of granolithic walks on Christie St., Nelson. St and Peter St., at cost of \$2,502. Town Clerk, S. L. Briggs.

Pembroke, Ont.—Town Council passed by-laws authorizing the widening of McAllister St. at cost of \$4,075; construction of bituminous macadam roadways on Hineks St.; and granolithic walk on Metcalfe St., \$1,131.

Pembroke, Ont.—Contract for asphaltic concrete construction of pavement awarded to the Warren Bituminous Paving Co. of Ontario, Ltd., at \$94,766.50. Other tenders received: Godson Contracting Co., Ltd., \$83,604; Grand Bros. Construction Co., Ltd., \$87,746.

St. John, N.B.—Plans and an estimate of cost for paving of north and south sides of Haymarket Square and Market Square have been completed.

Shipton Tp., Que.—Tenders will be received until noon, Saturday, July 1, for construction of bridge. Plans and specifications may be obtained on application to the Department of Public Works and Labor, Quebec, Que.

Winnipeg, Man.—City Council intends to construct granolithic walks on a number of streets. City Clerk, C. J. Brown.

Winnipeg, Man.—Contract for removal of westerly half of swing span of old Provencher Bridge was awarded to F. E. Buckham, 299 Beverley St., Winnipeg, at \$925.

Woodstock, Ont.—Following contracts were awarded in connection with construction of North Oxford Bridge: Concrete abutments, Frank Fogarty, Ingersoll, \$1,615; grading, George Wilkes, of Woodstock, \$1,500; steel work, Stratford Bridge & Iron Co., at \$3,250.

York Tp., Ont.—Tenders will be received by Frank Barber, Township Engineer, Toronto, until 12 o'clock noon, Saturday, July 8, for construction of concrete sidewalks. (See official adv.)

York Tp., Ont.—Following contracts awarded for construction of concrete sidewalks: Brumell Ave., \$750, Methuen Ave., \$2,500; Bude St., \$1,200, Dunvegan Road,

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XCELADUCT
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For All
Electrical
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lations

Manufactured by
National Conduit Co., Limited
Toronto

\$500, Normanna Ave., \$900, Britnell Contracting Co., Ltd.; Bungalow Rd., \$4,000, Chilton Ave., \$4,000, Hopedale Ave., \$6,200, Pape Ave., \$3,700, Stanhope Ave., \$3,400, D. McKay; Cedarville Ave., \$625, Woodycrest Ave., \$800, A. Johnson; Harshaw Ave., \$3,100, Willard Ave., \$2,000, National Contracting Co.; Wolverton Ave., \$2,000, Minton Place, \$2,200, H. S. Walter; Pepler Ave., \$3,400, P. Licastro & Co.; Warland Ave., \$3,500, J. J. Ramsay. Bituminous macadam pavements—Connaught Ave., Kilmer & Barber, \$8,000; Heathdale Road, Constructing & Paving Co., Ltd., \$6,000.

MISCELLANEOUS (Additional)

Barton Tp., Ont.—Tenders will be received until 6 p.m., Thursday, July 6, by James Atherton, Secretary, Board of Trustees, School Section Barton Tp., 200 East 23rd St., Hamilton, for erection of four-room school on Wellington St.; an eight or ten-room addition to Wentworth Street School; and a two-room addition to Brantdale Ave. School. Plans and specifications may be seen at office of J. A. Arnes, Architect, 67 Charles St., Hamilton.

Burlington, Ont.—Tenders were received until June 24 for several trades in connection with addition to school at Burlington Beach. Architects, McPhie & Kelly, Bank of Hamilton Building, Hamilton.

Buzwa, Ont.—Tenders addressed to Duncan C. Scott, Deputy Superintendent General of Indian Affairs, Dept. of Indian Affairs, Ottawa, will be received until noon, July 3, for combined day school and teachers' residence. Plans and specifications may be seen at the Post Office, Owen Sound; office of the Indian Agents, Gore Bay and Manitowaning; and at the Department at Ottawa.

Cambridge, N.S.—The villages of Cambridge and Waterville have completed the incorporation of a company to be known as the Cambridge-Waterville Hydro-Electric Power Co., Ltd., with a capital stock of \$20,000. President, J. G. Webster, Cambridge.

Dartmouth, N.S.—Tenders addressed to E. H. Armstrong, Minister of Public Works and Mines, for addition to store building, Nova Scotia Hospital, will be received until 12 o'clock noon, July 6. Plans and specifications may be seen at Mines Office, Halifax, and at office of Medical Superintendent, Nova Scotia Hospital, Dartmouth.

Essondale, B.C.—Tenders will be received by the Hon. the Minister of Public Works until 12 o'clock noon, Monday, July 3, for installation of heating and ventilation system for new Acute Building at the Mental Hospital, Essondale. Plans and specifications may be seen at office of the Government Agent, Court House, Vancouver; Government Agent, Court House, New Westminster; or Department of Public Works, Victoria, B.C.

Gross Isle, Que.—Tenders addressed to R. C. Desrochers, Secretary, Department of Public Works, Ottawa, will be received until 12 o'clock noon, Thursday, July 6, for construction of an extension to the eastern wharf. Plans and specifications may be obtained at Department of Public Works, Ottawa; at offices of District Engineers, Post Office Building, Quebec; Shaughnessy Building, Montreal; and at Post Office, Montmagny, Que.

High River, Alta.—Work will start shortly on construction of 2½-mile diversion canal from Highwood River to Little Bow River. Address, D. O. McKay, Little Bow Irrigation District, Lechbridge.

Inglewood, Ont.—Separate or bulk tenders addressed to T. H. Graham, Secretary, Board of Education, will be received until 5 o'clock p.m., Tuesday, July 1, for erection of three-roomed public school building. Plans and specifications may be obtained at office of the architects, Smith & Wright, Dominion Bank Chambers, 2945 Dundas St. West, Toronto.

Kenora, Ont.—Board of Education awarded contract to McKay & Davidson, of Winnipeg, for erection of four-room school building, for \$20,915. Other tenders received: Bergman & Nilson, \$25,400; Claydon Co., Ltd., Winnipeg,

\$23,400; Kelly & Robb, \$21,900; Lindstrom & Nilson, \$25,500.

London, Ont.—Tenders will soon be called by the authorities of Western University for the construction of a new science building and also a new main building. John M. Moore & Co., 489 Richmond St. W., London, Ont., are the architects in charge of the work. R. E. W. Hagarty, Temple Bldg., Toronto, is the consulting engineer.

London, Ont.—Contract has been awarded by the authorities of Western University to John Putherbough, 1006 Wellington St., London, for a three-span structural steel cantilever bridge, with concrete piers and with steelwork encased in 6 in. of concrete, to be built across the Thames River. The cost will be approximately \$110,000. The sub-contract for structural steel has been awarded to McGregor & McIntyre, Ltd., Toronto. John M. Moore & Co., 489 Richmond St. W., London, Ont., are the architects in charge of the work. R. E. W. Hagarty, Temple Bridge, Toronto, is the consulting engineer. Work will be started immediately.

New Liskeard, Ont.—Tenders addressed to W. H. Maund, Sec.-Treas., Temiskaming and Northern Ontario Railway Commission, North Bay, will be received until 12 o'clock noon, Friday, July 7, for erection of a brick freight shed. Plans and specifications may be seen at office of S. B. Clement, Chief Engineer, North Bay, and at office of E. M. Goodman, Agent, New Liskeard.

Ottawa, Ont.—Tenders addressed to Henry R. Washington, Clerk, Carlton County, will be received until June 30 for plumbing and heating required in addition to County Court House. Plans and specifications may be obtained at office of Architect, C. J. Burritt, Hope Chambers, Ottawa.

TENDERS PENDING

The following tabulation is presented as a reminder to contractors in regard to tenders that are still pending, other than those reported in this issue. The word "Issue" refers to the issue of "Canadian Engineer" in which there appeared a notice giving details regarding the call for tenders.

Place of Work	Tenders Close	Issue
Bridgeburg, Ont., erection of municipal building	Jul. 3	Jun. 20
Calgary, Alta., supply of cable	Jul. 6	Jun. 20
Calgary, Alta., supply of one motor-driven combination pumping engine and hose car	Jun. 30	Jun. 13
Cochrane, Ont., erection of school	Jun. 30	Jun. 20
East Missouri Tp., Ont., construction of bridge	Jun. 29	Jun. 13
Eganville, Ont., granolithic walks	Jul. 1	Jun. 20
Hensall, Ont., construction of pavement	Jun. 28	Jun. 20
Kentville, N.S., erection of church	Jul. 3	Jun. 20
Kincardine, Ont., dredging	Jun. 28	Jun. 20
Kinloss Tp., Ont., construction of drain	Jun. 29	Jun. 20
Lakeside, Ont., completion of drain	Jun. 29	Jun. 13
Nassau, New Providence, Bahamas, dredging	July 15	May 9
Ontario, Province of, work on Provincial Highways	July 7	Jun. 13
Port Burwell, Ont., repairs to breakwater	Jun. 28	Jun. 13
Port Colborne, Ont., repairs to breakwater	Jul. 4	Jun. 20
Port Hope, Ont., electric wiring and fittings for public building	Jun. 29	Jun. 20
Sombra Tp., Ont., completion of pavement	Jun. 28	Jun. 20
Toronto, Ont., erection of Nurses' Home	Jul. 4	Jun. 20
Toronto, Ont., supply and installation of sewage pump and motor	Jul. 18	Jun. 20
Welland, Ont., installation of steam heating system	Jun. 30	Jun. 20
West Nisouri Tp., Ont., construction of drain	Jul. 3	Jun. 20
York Tp., Ont., pavements and grading	Jul. 3	Jun. 20



The Contractor's First Choice Always

The Waterous double cylinder steam roller has been the first choice of contractors for over twenty-five years. That the confidence placed in the Waterous roller by the contractors of Canada is fully upheld is evidenced by the fact that when in need of additional rollers they insist on Waterous. This is because the Waterous roller is designed and built to earn money for its owner. Every detail of its engineering, every inch of the tested material in it, contributes directly and always to this one end.

Some years ago Wentworth County kept accurate costs of a Waterous roller and one of another make. The result showed that the Waterous roller worked in one year 202 days of 10 hours each and 76 nights of 12 hours each. The cost of repairs was \$189.00 which was practically the total cost of repairs incurred since it was bought, and it has been in service five years.

The other make of roller was in operation 129 days of 10 hours each, and 18 nights of 12 hours each and cost \$197.00 for repairs, being in operation four seasons.

The above figures show that the Waterous roller not only did 250 per cent more work but did it at a maintenance cost of 23 percent less.

Waterous

BRANTFORD, ONTARIO, CANADA

Ottawa, Ont.—Bulk tenders addressed to Henry R. Washington, Carleton County Clerk, will be received until June 30 for addition to County House. Plans and specifications may be obtained at office of architect, C. J. Burritt, Hope Chambers, Ottawa.

Ottawa, Ont.—Bulk or separate tenders will be received by the Public School Board until noon, Thursday, June 29, for several works required for erection of an Administration Building corner of Gilmour and O'Connor Sts. Plans and specifications may be seen at the office of W. C. Beattie, Superintendent of Buildings, Elgin Street School Building.

Port Dover, Ont.—E. A. James, Engineer, Toronto, submitted plans for a water works and for a sewerage system to the Town Council. By-law will be submitted to ratepayers.

Port Hope, Ont.—Tenders addressed to R. C. Desrochers, Secretary, Department of Public Works, will be received until 12 o'clock noon, Thursday, June 29, for electric wiring and fittings in the public building, Port Hope.

Quebec, Que.—Provincial Department of Public Works awarded following contracts for construction of extension to Quebec Court House: Roofing, Eugene Falardeau; woodwork, Morrisette, Ltd.; masonry, E. Frenette; granite, Jobin & Genois; lime, Deschambault Quarry. Contracts aggregate \$263,000.

Riverside, Ont.—Council passed by-laws authorizing Town Engineer R. W. Code to prepare plans for a water main and sidewalks on both sides of Lauzon Road, from Riverside drive to the Hydro tracks; a water main and sidewalk on the east side of Jarvis St., from Riverside drive to Lot No. 42.

Riverside, Ont.—Following contracts were awarded for Riverside School for Roman Catholic Separate School Board, School Section 2: General contract, Cleveland Mousseau, Ford City, \$28,174; plumbing and heating, Windsor Plumbing & Heating Co., Windsor, \$5,375; electric wiring, E. H. Mailloux, Riverside, \$314.

St. John, N.B.—Tenders will be received by A. Gordon Leavitt, Secretary, School Trustees, until 12 o'clock noon, June 30, for erection of brick and concrete school building on Duke St., West End. Plans and specifications may be seen at office of Architect, F. Neil Brodie, 42 Princess St., St. John.

St. Thomas, Ont.—Tenders will be received until 12 o'clock, Tuesday, July 4, by Darrach & Findlay, architects, 430 Talbot St., St. Thomas, for several trades required in erection of a swimming pool and gymnasium for Alma Ladies' College.

Tierford, Ont.—Bosanquet Township Council provisionally adopted the report of Engineer George A. McCubbin, of Chatham, on big Canadian Company drain. Estimated cost, \$59,000. Work will be commenced this summer.

Toronto, Ont.—Tenders addressed to the Superintendent of the Merrill Corporation, No. 3 Earl St., will be received until 5 p.m., July 6, for the erection of apartment hotel at No. 3 Earl St.

Toronto, Ont.—Contracts for laying and jointing of 6-in. water pipes awarded as follows: Burgess Ave., Cedarville Ave., Heath St. E., Old Orchard Grove, Rusholme Road, to Grant Contracting Co., Ltd., at total of \$2,083.

Toronto, Ont.—Tenders will be received, addressed to the Chairman, Board of Control, City Hall, until 12 o'clock noon, Tuesday, July 4, for one Iron Planer. Specifications may be obtained at Room 12, City Hall.

Toronto, Ont.—Tenders addressed to C. A. Maguire (Mayor), chairman, Board of Control, will be received until noon, Tuesday, July 11, for laying and jointing of 6-in. water pipes in Brookside Drive, Cranbrooke Ave., Hillhurst Blvd., Nelles Ave. and Rosewell Ave. Specifications may be obtained on application at Room No. 320, City Hall.

Toronto, Ont.—Tenders addressed to C. A. Maguire (Mayor), chairman, Board of Control, will be received until Tuesday, July 11, for supply and installation of weigh scales on west side of Keele St., south of Dundas St. Specifications may be obtained at office of Property Department, City Hall.

Toronto, Ont.—Tenders addressed to W. W. Pearce, Business Administrator and Secretary-Treasurer, Board of Education, will be received until Monday, July 3, for (1) Masonry, structural steel, ornamental iron, steel sash, carpentry, roofing, tin-smithing, plastering, painting, glazing, terrazzo and marble work, plumbing, heating, ventilating, heat regulation, electric wiring, local phones, for Kitchener School; (2) masonry, structural steel, ornamental iron, steel sash, carpentry, roofing and tin-smithing, plastering, painting and glazing, plumbing, heating and ventilating, electric wiring, for Malvern Collegiate; (3) fibre mastic floors for Dufferin School; (4) roofing and tin-smithing for Annette St. School; and (5) carpentry for Fern Ave. School. Specifications may be seen at office of the Architect of the Board, 155 College St.

Welland, Ont.—Zero-Zone, Ltd., has been incorporated with capital stock of \$500,000. Plant will be constructed at corner of Burglatt and Victoria Sts. President, Byron A. Baseue.

Condensed Advs.

Advertisements (not displayed) under this heading at following rates per insertion, with sixty-five cents per insertion as minimum rate in any case: "Positions Wanted," two cents per word; all other condensed advertisements, four cents per word. Payable in advance; 50 per cent. extra if charged.

POSITION WANTED: Graduate civil engineer, with four years' experience on surveys and municipal work, wishes to apprentice with an Ontario Land Surveyor. Box 58, Canadian Engineer, Toronto.

CAST IRON PIPE. Eight 12-ft. lengths, 48-in. Class A, Bell and Spigot, new, shipping point near Montreal. Box 55, Canadian Engineer, Toronto.

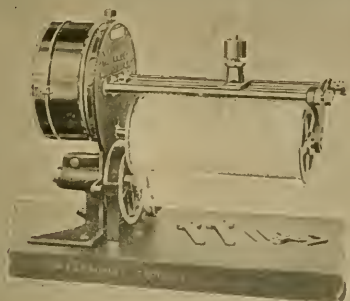
STRUCTURAL DRAFTSMEN—Wanted immediately, several experienced steel draftsmen. Give experience and state salary. Chief Engineer, Standard Steel Construction Company, Welland, Ont. —348.

CIVIL AND MECHANICAL ENGINEER with extensive experience in Engineering, Contracting, Purchasing and Finance open for engagement with Consulting Engineer, Contractor or Manufacturer. Box 56, Canadian Engineer, Toronto.

POSITION VACANT: Structural designer in steel and reinforced concrete. Must be able to take initiative. State fully, training and experience. Address Box 57, Canadian Engineer, Toronto.

GENERAL ENGINEERING AGENCY, PITTSBURGH, PA. Serving Employers everywhere overnight, require for proposals Structural Engineers, Architects, Designers, Hydro-Electric Power field and office executives and assistants, Reinforced Concrete Draftsmen, Electrical Draftsmen, Mechanical Draftsmen. —323.

PATENT NOTICE: Any one desiring to obtain the invention covered by Canadian Patent No. 200078, granted on May 11, 1920, to the Ivers-Lee Company, of Newark, New Jersey, United States of America, for Package and Method of Making the same, may do so upon application to the undersigned, who are prepared to supply all reasonable demands on the part of the public for the invention and from whom full information may be obtained. Fetherstonhaugh & Co., 15 Elgin Street, Ottawa, Canada, Russell S. Smart, resident. —364



GURLEY

Water Stage Registers

ENGINEERS engaged in water power development, water supply, irrigation and reclamation projects recognize the need for accurate data covering the height and volume of water in streams from which reliable determinations can be made—

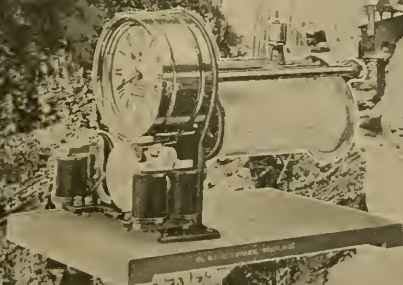
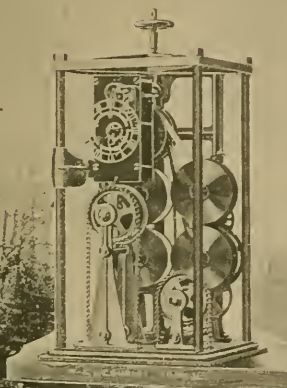
They further recognize the insufficiency of occasional observations and therefore the desirability of having hourly and daily records automatically made and recorded.

They have learned by experience that Gurley Water Stage Registers,—Graphic, Printing and Long Distance, unfailingly indicate and record the vital statistics upon which the Engineer can reliably base his calculations at all seasons.

A sympathetic understanding of requirements, reinforced by the "know-how" of precision instrument making, has placed the Gurley Organization in the lead in the estimation of a majority of Engineers.

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PUBLIC NOTICE
PROVINCE OF MANITOBA
DEPARTMENT OF PUBLIC WORKS
FAIR WAGE SCHEDULE, 1922

Public Notice is hereby given that under the provisions of Section 10 of Chapter 121 of the Statutes of Manitoba, 1916 (being the Fair Wage Act, 1916), the Minister of Public Works has approved of the rate per hour and working hours, set forth in the following Schedule, as the Minimum rate per hour payable to any employee engaged in the respective trades, and the maximum number of hours during which any employee engaged in the respective trades shall be required to work; and that the said Schedule shall apply and be effective for employees engaged on Public Works on or at the Building, and that the said Schedule shall be effective from the first day of June, 1922, until the thirtieth day of April, 1923, or until such time as another order may be made by the said Minister of Public Works.

Fair Wage Schedule for Winnipeg

The following Schedule shall apply to the City of Winnipeg, and a radius of Thirty Miles therefrom, effective from the first day of June, 1922, to the thirtieth day of April, 1923.

	Rate per Hour	Hours per Week
1. Laborers.		
(a) Skilled. Comprising the following: Unloading, Piling and handling Face Brick, Cut Stone, Architectural Terra Cotta, Marble, real or imitation, Roofing Slate, Plaster Castings, Ornamental Bronze and Iron, Interior Joinery, Laying Drain Tiles, Mixing concrete by machinery, Puddling concrete in forms or levelling in slabs, Bending and Placing Reinforcing Material, Movable Scaffolding and Runways....	.50	50
(b) Unskilled. Comprising all Labor other than the occupations above defined or elsewhere provided for in this Schedule.....	.42 1/2	54
2. Teamsters.....	.50	60
3. (a) Bricklayers.....	1.07 1/2	44
(b) Helpers		
1. Mixing and Tempering Mortar....	.55	50
2. Attending Bricklayers on or at Scaffold.....	.50	50
4. (a) Stonemasons.....	1.07 1/2	44
(b) Helpers		
1. Mixing and Tempering Mortar....	.55	50
2. Attending Stonemasons on or at Scaffold.....	.50	50
5. Cement Finishers.....	.70	50
6. (a) Marble Setters.....	1.05	44
(b) Helpers.....	.55	50
7. (a) Mosaic and Tile Setters.....	1.00	44
(b) Helpers.....	.55	50
8. Terrazo Workers		
(a) Layers.....	.72 1/2	44
(b) Helpers.....	.55	50
9. Stonecutters		
(a) Carvers.....	1.07 1/2	44
(b) Journeymen.....	.95	44
10. (a) Plasterers.....	1.00	44
(b) Helpers.....	.55	50
11. Wood, Wire and Metal Lathers.....	.80	44

12. (a) Plumbers.....	.90	44
(b) Helpers.....	.50	50
13. (a) Steamfitters.....	.90	44
(b) Helpers.....	.50	50
14. Operating Engineers on Construction		
(a) Engineers in charge of machines of 3 or more drums.....	1.00	50
(b) Engineers in charge of double drum machines.....	.90	50
(c) Engineers in charge of single drum machines.....	.80	50
(d) Firemen.....	.60	50
15. Sheet Metal Workers.....	.75	44
16. Painters, Decorators, Paperhangers and Glaziers.....	.75	44
17. Blacksmiths.....	.75	44
18. Electrical Workers, Inside Wiremen.		
(a) Licensed Journeymen.....	.85	44
(b) Journeymen working under permit.....	.77 1/2	44
(c) Experienced Helper.....	.65	44
(d) Helper.....	.45	44
19. Asbestos Workers		
(a) Journeymen.....	.80	44
(b) First Class Improvers.....	.70	44
20. Asphalters		
(a) Finishers.....	.65	44
(b) Men engaged preparing, mixing and heating materials.....	.50	50
21. (a) Carpenters.....	.85	44
(b) Helpers.....	.50	50

Fair Wage Schedule for Province of Manitoba
(Exclusive of Winnipeg)

The following Schedule shall apply to any portion of the Province of Manitoba, other than the City of Winnipeg, and a radius of Thirty Miles therefrom, effective from the first day of June, 1922, to the thirtieth day of April, 1923.

	Rate per Hour	Hours per Week
1. Laborers		
(a) Skilled. Comprising the following: Unloading, Piling and handling Face Brick, Cut Stone, Architectural Terra Cotta, Marble, real or imitation, Roofing Slate, Plaster Castings, Ornamental Bronze and Iron, Interior Joinery, Laying Drain Tiles, Mixing concrete by machinery, Puddling concrete in forms or levelling in slabs, Bending and Placing Reinforcing Material, Movable Scaffolding and Runways....	.45	50
(a) Unskilled. Comprising all Labor other than the occupations above defined or elsewhere provided for in this Schedule.....	.40	54
2. Teamsters.....	.45	60
3. (a) Bricklayers.....	1.07 1/2	44
(b) Helpers		
1. Mixing and Tempering Mortar....	.50	50
2. Attending Bricklayers on or at Scaffold.....	.45	50
4. (a) Stonemasons.....	1.07 1/2	44
(b) Helpers		
1. Mixing and Tempering Mortar.....	.50	50
2. Attending Stonemasons on or at Scaffold.....	.45	50
5. Cement Finishers.....	.70	50
6. (a) Marble Setters.....	1.05	44
(b) Helpers.....	.50	50
7. (a) Mosaic and Tile Setters.....	1.00	44
(b) Helpers.....	.50	50
8. Terrazo Workers		
(a) Layers.....	.72 1/2	44
(b) Helpers.....	.55	50
9. Stonecutters		
(a) Carvers.....	1.07 1/2	44
(b) Journeymen.....	.95	44

(Concluded on Page 58)

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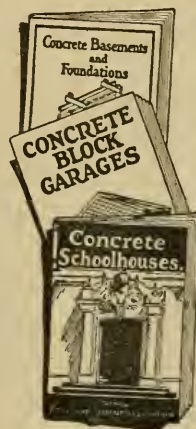
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MANITOBA FAIR WAGE SCHEDULE

(Continued from Page 56)

10. (a) Plasterers	1.00	44
(b) Helpers	.50	50
11. Wood, Wire and Metal Lathers	.80	44
12. (a) Plumbers	.90	44
(b) Helpers	.45	50
13. (a) Steamfitters	.90	44
(b) Helpers	.45	50
14. Operating Engineers on Construction		
(a) Engineers in charge of machines of 3		
or more drums	1.00	50
(b) Engineers in charge of double drum		
machines	.90	50
(c) Engineers in charge of single drum		
machines	.80	50
(d) Firemen	.60	50
15. Sheet Metal Workers	.75	44
16. Painters, Decorators, Paperhangers		
and Glaziers	.75	44
17. Blacksmiths	.75	44
18. Electrical Workers, Inside Wiremen.		
(a) Licensed Journeymen	.85	44
(b) Journeymen working under permit..	.77 1/2	44
(c) Experienced Helper	.65	44
(d) Helper	.45	44
19. Asbestos Workers		
(a) Journeymen	.80	44
(b) First Class Improvers	.70	44
20. Asphalters		
(a) Finishers	.65	44
(b) Men engaged preparing, mixing and		
heating materials.. ..	.50	50
21. (a) Carpenters	.85	44
(b) Helpers	.45	50

Dated at Winnipeg, this 5th day of June, 1922.

S. C. OXTON,
Deputy Minister of Public Works and
Chairman Fair Wage Board.—359

Tenders Called For

TOWN OF THESSALON, ONTARIO

HYDRO ELECTRIC POWER DEVELOPMENT

Sealed tenders marked and addressed to Mr. John Coulter, Town Clerk of Thessalon, will be received up to July 8, 1922, for the supply of materials, erection and construction of the following works:

Contract A

200-H.P. Water Turbine with governor, etc., directly connected to a 175-K.V.A. generator, complete with switchboard, exciter, etc., and erected in the Power House.

Contract B

Construction of dam, head works, 48-in., Wood Stave pipe line, power house and tail race.

Plans and specifications may be seen at the office of the Consulting Engineers or at the office of the Town Clerk at Thessalon and a set of plans and specifications may be obtained from the Engineers for the use of the contractor upon deposit of \$10.00, which will be returned when the said plans are returned.

The lowest or any tender not necessarily accepted.

W. A. BRIDGE, ESQ.,

Mayor.

JOHN O. COULTER, ESQ.,

Clerk.—362

JAMES, PROCTOR & REDFERN, LIMITED,
Consulting Engineers,
36 Toronto Street, Toronto.



TOWNSHIP OF YORK

Tenders, Pavements and Grading

Sealed Tenders, plainly marked as to contents, will be received by the undersigned up to 12 o'clock July 3rd, 1922, for the construction of Bituminous Macadam Pavements on Dunvegan Road and Forest Hill Road, also as Asphalt Pavement on Normanna Avenue and the grading of Bicknell Avenue.

Plans and specifications may be seen at the office of the undersigned, 40 Jarvis Street, Toronto.

The lowest or any tender will not necessarily be accepted.

FRANK BARBER,

Township Engineer.

Frank Barber and Associates Limited,
Consulting Engineers,

40 Jarvis Street, Toronto. —362
Toronto, June 19th, 1922.

TOWNSHIP OF YORK

TENDERS FOR CONCRETE SIDEWALKS

Sealed Tenders, plainly marked as to contents, will be received by the undersigned up to 12 o'clock Noon of Saturday, July 8, 1922, for the construction of concrete sidewalks on Alameda Avenue, Avon Avenue, Brunswick Avenue, Dentonia Park Avenue, Eastdale Avenue, Humewood Drive, Gordon Avenue, Keene Steert, Kendal Avenue, Lumsden Avenue, Meagher Avenue, Mould Avenue, Orla Avenue, Pritchard Avenue, Runnymede Road, Strathearn Blvd., and Walnut Avenue.

Plans and specifications may be seen at the office of the undersigned, 40 Jarvis Street, Toronto.

The lowest or any tender will not necessarily be accepted.

FRANK BARBER,

Township Engineer.

FRANK BARBER AND ASSOCIATES LIMITED,

Consulting Engineers,

40 Jarvis Street, Toronto.—365
Toronto, June 26, 1922.

TOWNSHIP OF ETOBICOKE

TENDERS FOR WATERWORKS, Area No. 3.

Sealed tenders, plainly marked as to contents and addressed to the undersigned, will be received up to ten o'clock a.m., Monday, July 3, 1922, for the following works:

- (1) Supplying 8-in. and 6-in. cast iron pipe.
- (2) Supplying special castings.
- (3) Supplying Valves and Hydrants.
- (4) Supplying Meter Pumps, etc.
- (5) Laying about 5,850 ft. of 8-in. main.
- (6) Laying about 5,850 ft. of 8-in. main.
- (7) Laying about 7,700 ft. of 6-in. main.
- (8) Building Pump House.

Plans and specifications may be seen and tender forms obtained from the office of the Township Engineer.

FRANK BARBER,

Township Engineer.

FRANK BARBER AND ASSOCIATES, LTD.,

Consulting Engineers,
40 Jarvis Street, Toronto.

W. J. GUARDHOUSE, Reeve.

S. BARRETT, Clerk.

Islington, Ont.—366
Toronto, June 24, 1922.

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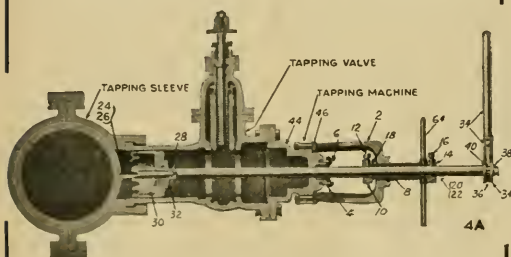
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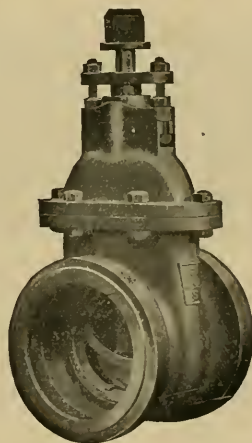
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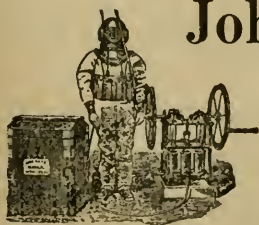
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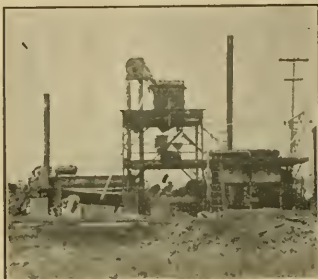
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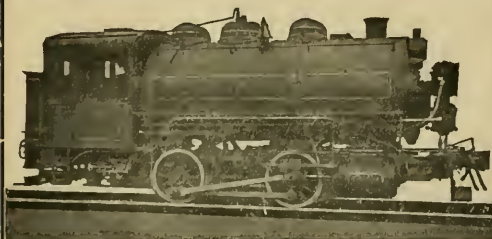
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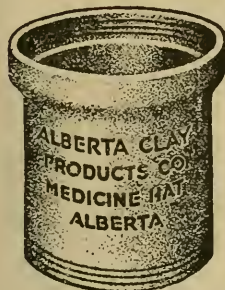
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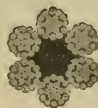
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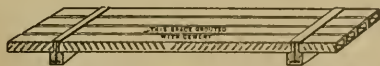
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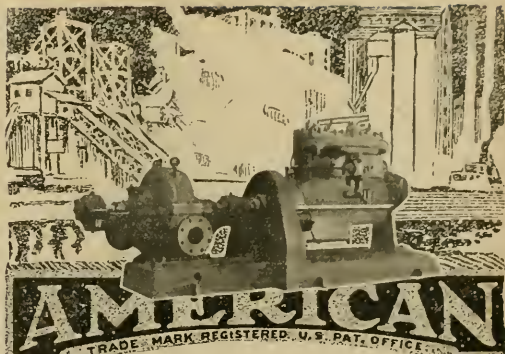
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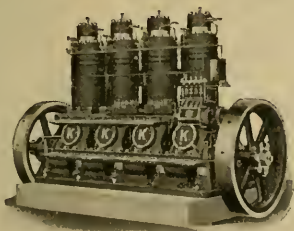
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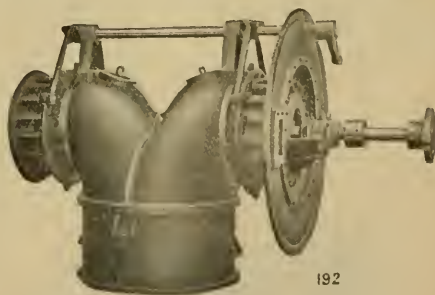
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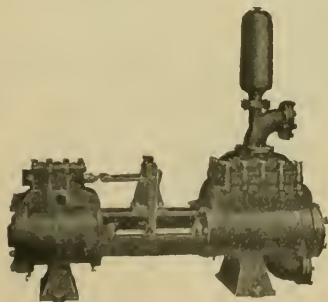
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